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WEEKLY 20 September 2025

SPECIAL ISSUE

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THE X7

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A note from the editor

Dear reader,

Preparations are now well under way for New Scientist Live, our unmissable festival of science and ideas.

We are back at Excel London from 18–19 October, and if you haven't been before, this is our annual extravaganza that is a real-life incarnation of *New Scientist*. You can enjoy talks from some of the world's most interesting scientists, journalists and environmentalists about everything from particle physics to the chemistry of baking. I am particularly looking forward to hearing cognitive neurologist Gina Rippon discuss neurodiversity with naturalist Chris Packham on 19 October, while my kids can't wait to see Big Manny, who has made Bunsen burners cool again. Whatever your interests, you are bound to leave with a head full of new ideas and a fresh perspective on the world we live in.

In between speakers, there's plenty to entertain on the show floor, with exhibitors including the hospital of the future and the chance to program a quantum computer. And this year we have a brand new feature: smaller, interactive workshops where you can take part in hands-on activities like forensics and whisky tasting.

There's still time to book an early bird discounted ticket. And if you can't make it to the festival in person, do join us online, where all our talks will be streamed live. Visit newscientistlive.com for further details.

I hope to see you there.

Catherine de Lange
New Scientist editor

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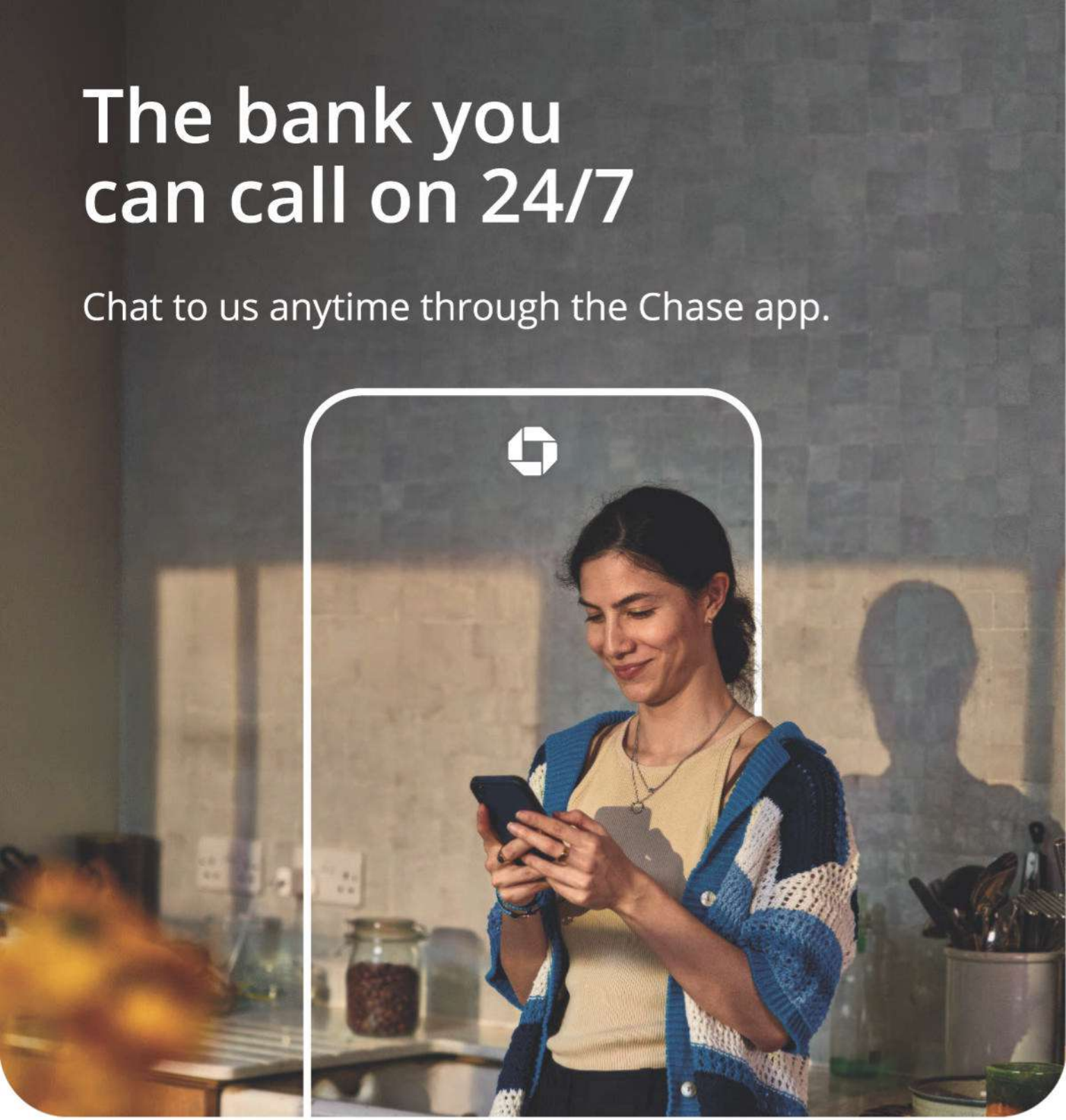

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Advertorial paid for by Alzheimer's Society

The nurses transforming dementia research

A pioneering new programme is set to reshape dementia trials, with research nurses leading the way

Laura Rooney, Lead Research Nurse at Alzheimer's Society

Nearly one million people in the UK are estimated to have dementia, the UK's biggest killer. Yet, dementia research progress is stalling as dementia clinical trials struggle to recruit.

In 2023/24 only 26 dementia clinical trials were supported by the National Institute of Health and Care Research (NIHR) and only 328 people took part in these trials. We know that only one in ten people with dementia are offered the opportunity to take part in clinical trials in England, Wales and Northern Ireland.

Alzheimer's Society is investing £3 million to establish the first UK-wide team of Dementia Research Nurses. This three-year pilot programme is set to revolutionise the dementia clinical research landscape in the UK – empowering more people with dementia to join vital clinical trials.

Alzheimer's Society UKDTN Research nurses will be embedded in the UK Dementia Trials Network – a £49.9m initiative funded by the UK government which is setting up dedicated early phase clinical trial teams at 20 centres in the NHS.

"Alzheimer's Society is investing £3 million to establish the first UK-wide team of Dementia Research Nurses"

New treatments

The Research Nurses will work to ensure the chance to take part in research is a core part of dementia care and will work with local clinicians and communities to make clinical trials more accessible regardless of background, location or other factors.

This is critical as new treatments must benefit everyone.

Dr Richard Oakley, Associate Director of Research and Innovation at Alzheimer's Society said, "For too long, there have been staggeringly low numbers of participants in dementia trials and there is an urgent need to address this if real progress is to be made in dementia research.

"Our new programme will get nurses on the ground recruiting people from as many different communities and backgrounds as we can into clinical trials, providing support throughout their research journey."

Find out more at alzheimers.org.uk/research-nurses

DEMENTIA IS AT A TIPPING POINT

Due to transformational breakthroughs, there is hope for a future where dementia will no longer devastate lives. We have to continue the momentum of research and that's why we're backing the brightest minds and have funded over £120 million of world-class dementia research to find the best ways to improve diagnosis, innovate care and develop targeted treatments.

Alzheimer's Society

It will take a society to beat dementia

The race to 100 is often rigged

The odds of becoming a centenarian are better than ever – but we can do even more

LIVING to 100. It is a milestone that, until recently, was so rare that hitting it would secure you newspaper inches and perhaps a segment on local radio. Today, it is an ambition well within reach for many of us. Last week, Japan celebrated a record number of centenarians – now almost 100,000. Globally, nearly half a million centenarians were alive in 2015, more than four times as many as in 1990. This is projected to rise to 3.7 million by 2050.

Much of this is down to advances in medicine, as well as a better understanding of what the human body needs to function at its full potential. We also now know much more about what we can personally do to enhance our chances of hitting triple figures. In our special issue (see page 36), you will learn how to eat, move and even think your way towards increasing the odds that you'll be blowing out 100 candles on your birthday cake.

Even so, personal decisions can only take us so far, and the reality is that there is a widening gap in both lifespan and healthspan between rich and poor. In

> "Globally, the number of centenarians is expected to reach 3.7 million by 2050"

the UK, people living in the richest areas now experience close to 18 extra years in good health than those in poorer regions, representing a disparity increase of 22 per cent for men and 17 per cent for women over a decade. A recent *Lancet* report showed that the US life expectancy gap between the longest-living demographic – Asian Americans – and the shortest-living – Native Americans and Native Alaskans – grew from 12.6 years in 2000 to 20.4 years in 2021. In India, as in the rest of the world, the covid-19 pandemic fuelled a chasm between the most and the least advantaged. In 2020, high-caste Hindus saw a decline in life expectancy of 1.3 years, while Indian Muslims lost 5.4 years. Such numbers are unacceptable. Access to nutritious food, safe housing and inoculation from the grinding stress of poverty are needed to stem rising disparities.

In our optimisation mission, let us not forget to pressure politicians to address this growing inequality. Living to 100 must be an ambition we can all aspire to – not solely the preserve of the world's wealthiest. ▮

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Technology

Quantum computers get silicon makeover

While this device may look like a time machine, it is actually a quantum computer – albeit one that has taken us further into the future. Made by Quantum Motion and now housed at the UK National Quantum Computing Centre, this is the first quantum computer fully built using standard silicon chip manufacturing techniques. It is a step towards achieving the mass production of quantum computers.

CHRISTY NUNNS AND QUANTUM MOTION

Health

Covid-19 vaccines' economic benefits

An estimate of the global health and economic impact of the vaccines against the coronavirus shows they delivered a huge return on investment, finds **Michael Le Page**

THE covid-19 vaccines cost $79 billion to develop and deliver globally, but they provided health and economic benefits worth between $5 trillion and $38 trillion worldwide in the first year alone, based on avoided infections, hospitalisations and deaths. That is a return on investment of between about $60 and $475 per dollar invested.

"These studies show the benefits that vaccines have, not just in terms of saving lives, but also that there is a strong economic argument," says Oliver Watson at Imperial College London. "Hopefully, this will highlight the value of continued investment in vaccine research and development."

Watson and his colleagues didn't attempt to estimate how much higher global economic growth was as a result of the vaccines than it would have been without them. Rather, their work is an estimate of the economic values of the health benefits, based on their previous 2022 study that estimated that covid-19 vaccines averted more than 14 million deaths in their first year of use.

For avoided infections, the team estimated how many days of work lost to illness were averted and the productivity value of those work days. For avoided hospitalisations, the team estimated the costs of the healthcare that wasn't required.

For deaths, the team estimated how many years of life were saved and the value of those years based on a measure of either how much society values years of life or how much people are willing to pay for an extra year of life – a standard approach used in many other studies.

The lower estimate of $5 trillion in benefits came from the approach based on how much society values lives, and the $38 trillion figure is based on how much individuals value their lives (medRxiv, doi.org/p5zv).

Looking at years of life saved means the estimate takes into account the fact that many of those whose lives were saved by vaccines weren't likely to live much longer, says Watson. Some other approaches put a value on lives saved regardless of age, which would result in a much higher estimate of the economic benefits.

$38 tn

Possible value of the covid-19 vaccines' health and economic benefits after just one year

"This study highlights the tremendous magnitude of benefits and returns on investment that covid vaccines brought nations throughout the globe," says Richard Carpiano at the University of California, Riverside. "Studies like this are important because resources are finite and policy-makers have to make important decisions about how to allocate resources."

"It shows that covid vaccination gave an excellent return on investment," says Angela Rasmussen at the University of Saskatchewan in Canada.

The analysis is timely given recent events, such as the decision by the US to discontinue half a billion dollars in funding for mRNA vaccine development, says Carpiano. Watson says the timing is a coincidence, as his team had been working on the estimates since before the last US election.

Watson's 2022 study estimating that vaccines saved more than 14 million lives in 2021 alone has come under fire from vaccine sceptics. A common claim is that it can't be right because the number of excess deaths – that is, deaths likely to be due to covid-19 – was even higher in 2021 than in 2020.

But 2021 was the year that many measures for controlling the spread of covid-19, such as lockdowns, were lifted, meaning many more people were exposed to the virus than in 2020, says Watson. Without vaccination, death rates would have been much higher. "Those kind of arguments struggle to understand that counterfactual," he says.

LILLIAN SUWANRUMPHA/AFP VIA GETTY IMAGES

Many lives around the world were saved thanks to the covid-19 vaccines

Saving lives

A study published in July this year estimated that covid-19 vaccines saved 2.5 million lives globally up to the end of 2024 – far less than the estimate from Watson's team. That is because the July study uses much lower figures for what proportion of people infected with covid-19 died, how many got vaccinated, how effective the vaccines were at preventing deaths and so on.

Watson thinks the numbers in his study are more accurate. Rasmussen also thinks the July study underestimates the number of lives saved. "But even if [the July] estimates are closer to the mark, more than 2 million lives saved is still very successful," she says.

Almost all other estimates of the number of lives that covid-19 vaccines saved are region-specific. For instance, a World Health Organization study estimated that covid-19 vaccines had saved 1.4 million lives in Europe alone by March 2023. "[This] broadly showed similar estimates to ours when we looked at the numbers for Europe," says Watson.

Ancient humans

Early Neanderthals hunted ibex on steep mountain slopes

Christa Lesté-Lasserre

NEARLY 300,000 years ago, Neanderthals had already figured out how to hunt mountain goats along vertical cliffs and process them in well-organised camps.

Known for ambushing large animals in western Europe's flat meadows and forests, it seems Neanderthals adapted to the hills of eastern Europe by adding ibex to their hunting regime. The early humans skinned and butchered the animals in a nearby cave before roasting their bones to obtain marrow and grease, showing impressive skill and knowledge far earlier than expected, says Stefan Milošević at the University of Belgrade in Serbia.

Neanderthals evolved about 400,000 years ago, but most of what we know about them comes from sites in western Europe that are less than 150,000 years old. So finding clues that fill in gaps in the Neanderthal timeline, habitat and culture is critical, says Marie-Hélène Moncel at France's National Museum of Natural History in Paris.

In 2017, archaeologists found Neanderthal remains in an approximately 290,000-year-old layer of the Velika Balanica cave in Serbia, making them the oldest such remains found in eastern Europe.

Since then, Milošević and his colleagues have discovered hundreds of stone tools and sifted through about 30,000 animal bone fragments in the cave. Nearly three-quarters of the fragments are slivers less than 2 centimetres long, and most of the identifiable ones are from ibex and red deer killed in spring and summer, suggesting the Neanderthals were seasonal cave dwellers (*Quaternary Science Reviews*, doi.org/p5rq).

Hunting mountain goats would have required impressive skills

Some bones – especially long deer legs – were burned and cracked open, meaning these early Neanderthals were probably heating bones to liquefy the marrow for easier extraction and leaving leftover fragments in the hearth so that bone grease would keep the fire burning.

SERGE GOUJON/SHUTTERSTOCK

Deer skeletons represented older youngsters and adults, a sign of selective hunting that promotes herd survival, says Milošević. But the ibex were killed at all life stages, suggesting the Neanderthals were still "rookies" up against mountain goats, probably hunting with sharpened sticks and rudimentary traps.

The researchers also found a few processed remains from wild boar, cave bears, wolves, foxes, leopards and various birds.

The organised positions of the bones in different sections of the cave point to distinct zones for specialised tasks. The hearth was in the centre, for example, with discarded bones piled up behind it, and the entrance appeared to be used as a tool workshop.

The findings point to "remarkable cognitive flexibility", says José Carrión at the University of Murcia in Spain. "It's a confirmation that Neanderthals were creative problem-solvers, managing complex habitats with ingenuity and skill. Neanderthals were humans – intelligent, social, and extraordinarily adaptive." ▮

Solar system

Jupiter is smaller and more squashed than we expected

JUPITER, the largest planet in our solar system, isn't as big as we thought, according to fresh measurements of its size.

As a gas giant it doesn't have a solid outer surface like Earth. But astronomers can still assess its shape by measuring how the height of its gas, at a certain pressure level, fluctuates around the planet, similar to measuring sea level on Earth.

Our best measurements were taken by NASA's Voyager and Pioneer spacecraft more than 40 years ago. The probes sent radio waves through Jupiter's atmosphere towards Earth, where the data was then examined and the radio waves' properties used to calculate the gas pressure at a given height, a technique called radio occultation.

Now, Eli Galanti at the Weizmann Institute of Science in Israel and his colleagues have measured Jupiter's size using radio occultation measurements from NASA's Juno spacecraft, which has been in orbit around the planet since 2016. They found that it is around 8 kilometres smaller on average than thought, with the reduction more notable around its poles, so the planet's shape is more squashed, or oblate.

Galanti presented the findings at the Europlanet Science Congress in Helsinki, Finland, on 11 September. He and his team took 13 different radio occultations with Juno and, together with known measurements of Jupiter's wind speeds, calculated its size.

"It's not just about knowing where the planet's radius is, but really understanding its internal workings"

For gas at 1 bar, which is the pressure of Earth's atmosphere at sea level, the planet measured 142,976 kilometres across at its equator and 133,684 kilometres across at its poles.

"It's not about just knowing exactly where the radius is, but it's really about understanding its internal workings," says Oded Aharonson at the Weizmann Institute of Science. "The planet's interior is mysterious and otherwise hard to probe, so having these new constraints could help us build more accurate interior models." ▮

Alex Wilkins

Analysis Health

Childhood obesity is now more common than undernutrition – what do we do?

Policies designed to reduce the consumption of unhealthy foods aren't working, finds **Grace Wade**

FOR the first time, more children worldwide are living with obesity than undernutrition. The shift indicates childhood malnutrition has entered a new phase, one that the world is ill-equipped to address.

Harriet Torlesse at UNICEF in Belgium and her colleagues analysed the nutritional status of children and young adults between 5 and 19 years old using data from the Non-communicable Disease Risk Factor Collaboration. This collaborative database spans more than 160 countries and territories, representing more than 90 per cent of children worldwide.

Their report revealed that, since 2000, global childhood obesity rates have roughly tripled. About 9.4 per cent of children today live with obesity, compared with 9.2 per cent who are undernourished – the first time that obesity has surpassed undernutrition among children.

The shift is largely driven by rising obesity rates in low- and middle-income countries, where "more than 80 per cent of children living with overweight and obesity in the world are", says Torlesse.

The implication is that governments and other organisations must rethink their approach to childhood malnutrition. "You're not just looking at undernutrition, you're looking at malnutrition in all its forms," says Shibani Ghosh at Cornell University in New York state.

The UNICEF report blames rising childhood obesity rates on the spread of ultra-processed foods. These products, made with industrialised processes, contain additives and preservatives. They also tend to be high in fats, sugars and salt. According to the report, ultra-processed foods account for at least half of the calories consumed by children in Australia, Canada, the US and the UK, and about a third of those consumed by children in some low- and middle-income countries, including Argentina and Mexico.

Numerous studies have associated ultra-processed foods with an increased risk of obesity. Yet policies designed to reduce consumption of them – many of which UNICEF recommends – rarely make a dent in obesity rates.

Consider taxes on unhealthy foods. In 2014, Mexico became the first country to tax certain high-calorie foods and sugar-sweetened beverages. Sales of these products subsequently fell, especially among lower-income households, but adolescent obesity rates barely budged. In fact, they dipped only in teenage girls, as was the case in the UK after it implemented a tax on sugary beverages in 2018.

But Torlesse sees it differently. "There is no single intervention that will do good," she says. "So you see some countries doing a soda tax, or some countries putting on food labels. That is all admirable, but unless you tackle it from all sides, we're not going to have the shift we need."

That is why the report also encourages policies that increase the availability and affordability of nutritious foods, such as subsidies or school lunch programmes.

No country has implemented all of UNICEF's recommendations, so it is still an open question whether they will be sufficient to rein in obesity.

"The implicit assumption is that because there is increasing consumption of unhealthy foods, overweight and obesity rates are increasing," says Ghosh. "And that could be one part of the explanation."

But there are probably additional drivers, too, such as stress, pollution and even genetic changes.

"We really need to see this as a holistic major public health emergency," says Andrea Richardson at RAND, a non-profit research organisation in California. "Our children are our future. They should all be healthy. If our children are not thriving, our future doesn't look very bright." ▮

Improving school lunches could be one way to boost children's nutrition

WILL & DENI MCINTYRE/GETTY IMAGES

Archaeology

Ancient toolkit brings us closer to hunter-gatherers

Christa Lesté-Lasserre

A SET of stone tools found in the Czech Republic appears to be the personal toolkit of a hunter-gatherer who lived about 30,000 years ago. The 29 artefacts, which include blades and points meant for hunting, skinning, basic butchering and cutting wood, offer a rare glimpse into the daily lives of ancient hunters, says Dominik Chlachula at the Czech Academy of Sciences in Brno.

"Many pieces were worn or broken, but the hunter may have kept them for their sentimental value"

In 2009, a village road collapsed in the Pavlovské vrchy mountains in the south-east of the country, opening up abandoned cellars that archaeologists began studying. In 2021, they found a deeper level of the site, called Milovice IV, containing charcoal dated to between 29,550 and 30,250 years ago. There, researchers discovered horse and reindeer bones, and, more recently, a bundle of stone tools, positioned as if they had been wrapped in a leather pouch that had long since decayed (*Journal of Paleolithic Archaeology*, doi.org/p5zs).

Most of the blades were worn down from cutting and scraping bones, wood and hides, and some bore marks of having been attached to a handle.

Further analyses revealed that about two-thirds of the tools had been crafted from glacial deposit flint stones found at least 130 kilometres to the north. Most of the others appeared to come from western Slovakia, about 100 kilometres south-east.

Many pieces were too worn or broken to be used as is, Chlachula explains. But it is possible the hunter kept them in the hope of recycling them – or even for their sentimental value. ▮

Cosmology

Black hole theorem proved correct

Gravitational wave observations are shedding light on an idea proposed by Stephen Hawking

Matthew Sparkes

STEPHEN HAWKING'S theorem on how black holes merge together has been successfully tested thanks to huge advances in gravitational wave astronomy, which helped astronomers catch the waves caused by an unusually powerful collision as they passed Earth at the speed of light.

Hawking proposed his black hole area theorem in 1971, which states that when two black holes merge, the resulting black hole's event horizon – the boundary beyond which not even light can escape the clutches of a black hole – cannot have an area smaller than the sum of the two original black holes. The theorem echoes the second law of thermodynamics, which states that the entropy, or disorder within an object, never decreases.

Black hole mergers warp the fabric of the universe, producing tiny fluctuations in space-time known as gravitational waves, which cross the universe at the speed of light. Five gravitational wave observatories on Earth hunt

"Some 300 black hole collisions have been recorded, but none as clearly as this one"

for waves 10,000 times smaller than the nucleus of an atom. They include the two US-based detectors of the Laser Interferometer Gravitational-Wave Observatory (LIGO) plus the Virgo detector in Italy, KAGRA in Japan and GEO600 in Germany, operated by an international collaboration known as LIGO-Virgo-KAGRA (LVK).

The recent collision, named GW250114, was almost identical to the one that created the first gravitational waves ever observed in 2015. Both involved black holes with masses between 30 and 40 times that of our sun and took place about 1.3 billion light years away.

AURORE SIMONNET/SSU/EDEON/LVK/IURI

Black hole mergers produce fluctuations in space-time called gravitational waves

This time, the upgraded LIGO detectors had three times the sensitivity they had in 2015, so they were able to capture waves emanating from the collision in unprecedented detail. This allowed researchers to verify Hawking's theorem by calculating that the area of the event horizon was indeed larger after the merger.

When black holes collide, they produce gravitational waves with overtones like the ringing of a bell, says Laura Nuttall at the University of Portsmouth, UK, a member of the LVK team. Previously these overtones have dissipated too quickly to be observed with enough clarity to calculate the area of the event horizons before and after the collisions, which was necessary to test Hawking's theory. A 2021 study on the first detected collision backed up the theory with a confidence level of 95 per cent, but the new research raises that confidence to a compelling 99.999 per cent (*Physical Review Letters*, doi.org/g927kn).

Making waves

In the 10 years that scientists have been observing gravitational waves, they have recorded some 300 black hole collisions. But none have been captured as strongly and clearly as GW250114, which was twice as loud as any other gravitational wave detected to date.

"The ones that are really, really close by – really, really loud in our data – they're the ones where we can really start probing into the fundamental physics of what's going on, just because they're so loud and the uncertainties are so small. So we can start really picking out the nitty gritty details of what's going on," says Nuttall. "We're just waiting for nature to keep giving us those beautiful things."

Only LIGO was operating when the waves from GW250114 reached Earth, not the other detectors monitored by the LVK collaboration. This didn't affect the test of Hawking's theory, but did mean researchers were unable to pinpoint the origin of the waves in the sky more clearly.

Upgrades to LIGO and other planned observatories due to come online in the future will bring even greater sensitivity and allow us to delve deeper into the physics of black holes, says Ian Harry, also at the University of Portsmouth and part of the LVK team. "We may not get all of them, but we will get an event like this again," says Harry.

The findings pave the way for new research on quantum gravity, through which physicists hope to unite general relativity and quantum physics. Nuttall says the latest results show general relativity and quantum mechanics continue to work well together, but some discrepancy is expected in the future.

The latest data from LVK also enabled scientists to confirm mathematician Roy Kerr's equations from the 1960s, which predicted that black holes can be characterised by just two metrics: their mass and their spin. In essence, two black holes with the same mass and spin are mathematically identical. Thanks to the observations of GW250114, we now know that to be true. ▮

New Scientist Live

Gravitational wave astronomy

See Katy Clough explain how we can detect gravitational waves on 18 October newscientist.com/nslmag

Astrobiology

NASA hasn't found life on Mars – yet

Fresh evidence could point to the existence of ancient organisms on the Red Planet, but we can't know for certain without returning samples to Earth, finds **Matthew Sparkes**

Has NASA discovered life on Mars?
In a word, no. But last year, NASA's Perseverance rover found signs in an ancient rock that could point to life having existed on the planet billions of years ago. And now we have more evidence in the form of small nodules of unusual minerals in several clay-rich rocks that could have a biological origin.

As exciting as the discoveries are, we need to proceed with caution: astrobiologists have a seven-step scale called the Confidence of Life Detection that puts a hard number on the quality of evidence. Even with the previous discovery and today's announcement combined, we remain on step one.

What has NASA actually found?
Last year, Perseverance was exploring a lake bed called Bright Angel in Mars's Jezero crater when it came across a rock with unusual markings called "leopard spots" and "poppy seeds". On Earth, these markings are considered to be telltale signs of ancient microbial activity. Leopard spots are millimetre-sized dark blots with a circular rim, while poppy seeds are even smaller dark blotches.

Both types of marking are found within the rock, which has been named Cheyava Falls after a waterfall in the Grand Canyon. And both types are sandwiched between white reams of calcium sulphate – a mineral that typically forms in the presence of water, another prerequisite for life.

Now, NASA has announced further intriguing discoveries: clay-rich rock samples found at two sites – one called Sapphire Canyon, found in Bright Angel again, and another called Masonic Temple – that have tiny, green-toned specks of chemically reduced iron phosphate and iron sulphide minerals.

NASA/JPL-CALTECH/MSSS

What makes these related to life?
On Earth, we know that both leopard spots and poppy seeds can be linked to microbial life: the reduction and oxidisation (redox) reactions that generate energy for such life forms leave coloured deposits of iron and sulphur in "reduced form", meaning they have gained electrons.

The marks in Cheyava Falls could have been caused by microbes or by another reaction

> **"This rock sample is the first time we've seen something that could be formed due to biological processes"**

that takes place only at high temperatures and isn't linked to the presence of life. But Perseverance's onboard instruments were used earlier this year to work out the chemical composition of the marks, showing that they do contain minerals in a reduced form. This suggests that the biological explanation is more likely.

NASA's Perseverance rover has found rocks with unusual markings

Now, on top of that, we have these new rocks. The green flecks of chemically reduced material could, just like the previous sample, indicate the presence of life. And even more excitingly, their distribution is uneven and directly related to the concentration of organic compounds – something that adds weight to the idea that they were created by living organisms.

Joel Hurowitz at Stony Brook University in New York state and his colleagues write in a paper on the new analysis, published in the journal *Nature*, that "the Bright Angel formation contains textures, chemical and mineral characteristics, and organic signatures that warrant consideration as 'potential biosignatures'." But, crucially, they haven't proved that living organisms were present on Mars (*Nature*, doi.org/g927zr).

How could we confirm the results?
We have all but exhausted our options for analysing Cheyava Falls and the new samples on the surface of Mars. What we really need to do is bring them back to Earth for a closer look.

Perseverance is designed to store interesting samples and hand them over to a future mission that will physically return them to Earth, but these plans have been hit by a series of setbacks in the past year or so. US President Donald Trump's proposal to slash NASA's budget is likely to mean that the Mars Sample Return mission is abandoned and any samples collected so far remain on the surface of the Red Planet, with no further analysis possible.

Team member Sanjeev Gupta at Imperial College London says the new discovery will add to the case for funding a sample-return mission, something NASA is very keen on. "This is the first time [we've seen] something that says, 'Oh, this could be formed due to biological processes' – and that's why the excitement is there. This is a sample we need to return," he says.

Is there anything more we can do from Mars?
When life emerged on Earth, it spread quickly. So one thing we can do is to look for repetition. Can we find other rocks with the same features?

"We're now outside Jezero crater looking at very ancient rocks just to see if we have evidence of similar sorts of processes or features. There's always a potential to go back to the same site and see if we can find more occurrences," says Gupta. "But really it's going to be about getting the sample back to Earth and analysing in Earth laboratories. That's the key." ▮

Probiotics: Separating fact from fiction
Megan Rossi breaks down the actual science behind live bacteria's role in our gut health on 18 October newscientist.com/nslmag

Health

Resistance training may also strengthen your gut microbiome

David Robson

THE most visible benefits of lifting weights may be bulging biceps, but strength training could also improve your gut health.

Certain configurations of microbes are consistently associated with better medical outcomes. These include *Faecalibacterium*, *Akkermansia* and *Roseburia hominis*, all of which produce short-chain fatty acids like butyrate that help protect the gut's lining and reduce inflammation.

Research has suggested that aerobic exercise – such as cycling or running – may help these microbial species to flourish. Studies examining the effects of resistance training have produced mixed results, however, with some revealing meaningful shifts, while others found minimal change.

To clear up the confusion, Sven Nahnsen at the University of Tübingen in Germany and his colleagues recruited 150 sedentary adults for an eight-week training programme that included various resistance exercises.

Unlike previous studies, the participants were given access to "smart" strength machines that automatically adjust the weight and range of motion according to their performance, while maintaining detailed records of their progress.

The participants also provided stool samples at the beginning, middle and end of the programme, which the researchers analysed to find the genetic and metabolic signatures of common gut microbes.

Across the group, there were no average changes to the microbiome composition after the programme. Instead, the effects seemed to depend on how well each individual responded to the training, with a correlation between the participants' increases in strength and the shift in their microbiome.

> "The findings support the notion that exercise can positively affect gut health"

Those who experienced the greatest gains in muscle power showed higher proportions of *Faecalibacterium* and *Roseburia hominis* at the end of the programme, for instance (bioRxiv, doi.org/p5qz). Exactly why some people responded better than others is unclear.

It is worth noting that the trial lacked a control group of people who didn't do any form of exercise. Even so, Matthieu Clauss at the Norwegian School of Sport Sciences in Oslo is positive about the results. "The findings support the notion that exercise, regardless of its type, can positively affect gut health," he says. ▮

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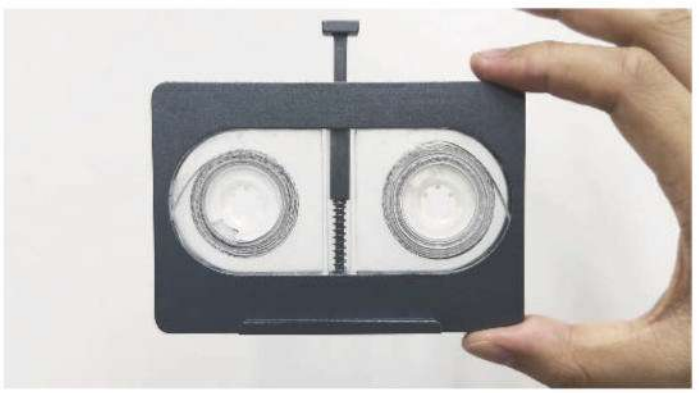
Technology

DNA cassette can store every song ever recorded

James Woodford



JIANKAI LI ET AL. 2025

This tape combines the look of a cassette with the storage capabilities of DNA

RETRO cassette tapes may be making a comeback, with a DNA twist. While DNA has been used as an information storage medium before, researchers have now combined this with the convenience and look of a 1980s cassette tape, creating what they are calling a DNA cassette.

Xingyu Jiang at the Southern University of Science and Technology in Guangdong, China, and his colleagues created the cassette by printing synthetic DNA molecules onto a plastic tape. "We can design its sequence so that the order of the DNA bases (A, T, C, G) represents digital information, just like 0s and 1s in a computer," he says. This means it can store any type of digital file, whether text, image, audio or video.

"The total data storage capacity is 36 petabytes – equivalent to 36,000 terabyte hard drives"

One problem with previous DNA storage techniques is the difficulty in accessing data, so the team then overlaid a series of barcodes on the tape to assist with retrieval. "This process is like finding a book in the library," says Jiang. "We first need to find the shelf corresponding to the book, then find the book on the corresponding shelf."

The tape is also coated in what the researchers describe as "crystal armour" made of zeolitic imidazolate, which prevents the DNA bonds from breaking down. That means the cassette could store data for centuries without deteriorating.

While a traditional cassette tape could boast around 12 songs on each side, 100 metres of the new DNA cassette tape can hold more than 3 billion pieces of music, at 10 megabytes a song. The total data storage capacity is 36 petabytes of data – equivalent to 36,000 terabyte hard drives (*Science Advances*, doi.org/p5j7).

However, says team member Jiankai Li, also at the Southern University of Science and Technology, if you put one of the new tapes into an old-fashioned Walkman, it won't produce any meaningful sound, because the DNA cassette doesn't use the magnetic signals of its predecessor.

"Our tape carries DNA molecules," says Li. "In other words, it would be like trying to play a photo in a record player – the formats are incompatible." ▮

Health

Area of brain behind cravings identified

Carissa Wong

A BRAIN structure that seems to influence food consumption could one day be targeted to enhance interventions for weight loss or gain.

Studies have shown that activating neurons in this structure, called the bed nucleus of the stria terminalis (BNST) – located around the centre of the brain and about the size of a sunflower seed in people – increases food intake in mice. But it was unknown whether taste influences its activity.

To learn more about its function, Charles Zuker at Columbia University in New York and his colleagues first imaged the brains of mice while they drank water flavoured with one of the five basic tastes – sweet, bitter, sour, salty and umami. The researchers previously linked enjoying sweet tastes to activity in a region called the amygdala, and have now pinpointed neurons there that only became activated in response to sweet water.

These neurons then activated others in the BNST, sometimes called the "extended amygdala". This is the first evidence that this structure receives taste signals, says Haijiang Cai at the University of Arizona.

The researchers then wanted to understand whether these activated BNST neurons influence dietary consumption, so they genetically engineered the cells so that they didn't activate when mice tasted sweet water. Over 10 minutes, these mice drank substantially less than normal ones, suggesting that activation of BNST neurons enhances consumption of sweet tastes (*Cell*, doi.org/p5k4).

But the researchers also found that this artificial activation prompted mice to consume more water of any taste, including whether it was unflavoured, salty or bitter, despite them usually avoiding the latter taste.

In further experiments, the team found that substantially more BNST neurons were activated by sweet and salty signals in hungry or salt-depleted mice, respectively, compared with those that were fed until they were full or had normal salt levels. This suggests that the BNST integrates signals for hunger and nutrient depletion, in addition to taste, to determine food intake, says Cai.

The findings are highly relevant to people, as our BNST is very similar to that of mice, says Cai. They suggest that developing drugs that activate BNST neurons could potentially help to encourage eating in people with a severe loss of appetite, such as those undergoing cancer treatment, he says.

However, more than a dozen brain pathways have been linked to food intake, says Cai, and some of these may compensate for any prolonged drug-related changes in BNST activity, so targeting multiple feeding circuits simultaneously will probably be needed, he says.

The study could also help us achieve better results with weight-loss treatments, such as the GLP-1 drug semaglutide. These can bind to neurons in the BNST, so a better understanding of how it alters food consumption could help us gain a clearer picture of how such drugs work and how to make them more effective in people with a poor response, says Sarah Stern at the Max Planck Florida Institute for Neuroscience. ▮

Human evolution

How elements shaped our evolution

Adaptation to local micronutrient levels, once vital, continues to influence populations worldwide

Michael Le Page

IN THE past, the quantity of zinc and other trace elements in human diets was determined largely by levels in local soils. Now it has been shown that our ancestors evolved to cope with local variations in micronutrient levels as they migrated around the world.

Jasmin Rees at the University of Pennsylvania and her team have scanned nearly 900 genomes of people from all around the world to find evidence of adaptation to local levels of 13 trace elements, including iron, manganese and selenium. To do so, they looked for signs of positive selection in 270 genes linked to uptake of these elements – that is, for gene variants that became more common in specific populations because they provided an advantage.

The strongest evidence was in iodine-linked genes in Maya peoples of Central America. Similar signatures were also found in the Mbuti and Biaka peoples in Central Africa, who are shorter than most people (*The American Journal of Human Genetics*, doi.org/p5md).

In 2009, it was suggested that the Mbuti and Biaka peoples' short stature could be due to adaptation to low iodine. This is because iodine-linked genes influence thyroid hormone activity, which has an effect on growth. These peoples are also known to be less prone to goitre – enlargement of the thyroid gland due to an iodine-deficient diet – than neighbouring groups.

Because the Maya population is also very short, says Rees, her findings support the idea that adaptation to low iodine affects height. She and her colleagues also point out that the rainforest soils in the Maya region are known to be low in iodine.

The Maya population may have evolved to cope with low levels of iodine

ROBERT FRIED/ALAMY

"This is very speculative," she says. "We can't say exactly what is causing these short statures, but we're seeing, at the very least, a coincidence where there seems to be selection on iodine-associated genes in these short-statured populations."

In the Uyghur and Brahui peoples of Central and South Asia, where soil magnesium levels are especially high, there is strong selection affecting two genes related to magnesium uptake. Some of these gene variants have previously been linked to low levels of magnesium in the body, so the team suggests these changes reduce magnesium uptake to prevent toxicity from high levels in the environment.

These are just two examples – the team found signs of positive selection related to at least one micronutrient in just about every population around the world.

"It would be important to know if individuals from particular populations are likely to be especially in need of particular micronutrient supplements," says Mark Stoneking at the Max Planck Institute for Evolutionary Anthropology in Germany.

"When it comes to identifying signatures of selection from genomic data, they have done state-of-the-art work," he says. "But a lot more work needs to be done to verify that these have been truly subject to selection." ▮

Solar system

Mysterious cloud on Mars finally has an explanation

A THIN cloud that appears on Mars each year has baffled astronomers ever since it was first spotted, but it may be the result of a moisture-rich atmosphere that was thought impossible.

Each winter, an 1800-kilometre-long cloud forms near Mars's Arsia Mons volcano in the south of the planet, appearing and disappearing every day for nearly three months. The conditions in Mars's atmosphere are markedly different to Earth's, such as containing many more small dust particles that can trigger water vapour in the air to condense into cloud particles. This produces many cloud patterns that we don't see on Earth, but simulations that include these high dust levels still can't form the Arsia Mons cloud's distinctive features.

Now, Jorge Hernández Bernal at Sorbonne University in France and his colleagues say they can reproduce the cloud's features if there is an extremely high amount of water vapour in the air, something that was previously thought impossible in Mars's atmosphere because of the high dust levels. These high water vapour levels help cloud particles form through an alternative, dust-free route called homogeneous nucleation.

When the researchers ran simulations of the atmosphere around Arsia Mons with much higher levels of water in the air, the resulting cloud looked strikingly similar to the real cloud, with a long tail stretching away from the volcano which then spreads out to form what is known as an outburst.

"It may be due to high levels of water in the air, which was thought impossible in Mars's atmosphere"

"Homogeneous nucleation requires, in the case of Mars, a much higher level of [water] saturation. This is why, in principle, we thought that this was not possible on Mars, or was very unlikely," Hernández Bernal told the Europlanet Science Congress (EPSC) in Helsinki, Finland, on 10 September. "But in the last decade, we have learned that there is, in fact, supersaturation on Mars." ▮

Alex Wilkins

Archaeology

Britain's economy actually thrived after the withdrawal of the Roman Empire

Michael Marshall

WHEN the Roman Empire withdrew from Britain, the result wasn't economic collapse. The metals industry in what is now northern England continued and even expanded in the subsequent centuries, according to an archaeological record of pollution from metalworking.

"The argument has been that, with the disappearance of state apparatus and linked state transport systems, the regional economies collapse totally," says Christopher Loveluck at the University of Nottingham in the UK.

Loveluck is part of a team that has excavated Roman remains from Aldborough in North Yorkshire, England. Under Roman rule, this town was called Isurium Brigantum, where metals like iron and lead were mined and processed.

The team found aerosol pollution from these metalworking operations had become trapped in the silt accumulating in an ancient riverbed at the archaeological site. By digging through the layers of sediment, the team was able to reconstruct how pollution levels varied between AD 345 and 1779.

In the late 300s and early 400s, the Roman Empire lost control of Britain and withdrew. The following centuries have few written records, and certain industries – notably wheel-thrown pottery – went into steep decline. This gave rise to a narrative of "the society of 5th-century Britain just collapsing", says Loveluck.

The riverbed record tells a different story. Lead pollution was low during Roman times, and fell only slightly in the late 300s and early 400s. It then rose steadily until the mid-500s. Likewise, pollution from ironworking rose during the first half of the 500s (*Antiquity*, doi.org/g93chw).

This, argues Loveluck, suggests continuity in the large-scale production of essential commodities.

The rise in metal production may have been due to internal fighting, suggests Jane Kershaw at the University of Oxford. "It's a period where the various Anglo-Saxon kingdoms are coalescing," she says. "There's a lot of fighting between those different kingdoms."

Metal production then declined sharply in the mid-500s, and remained low for several decades. The team suggests this might be due to the Justinianic plague, which cut through the lands around the Mediterranean in AD 541-549. Ancient DNA evidence from a graveyard in eastern England shows the plague did reach Britain. However, it isn't clear how severe or widespread it was.

"If everything was so terrible and dark, how come they're wearing these amazing brooches?"

The period after the Roman withdrawal has been dubbed the Dark Ages, due to a lack of written records and supposed intellectual decline. However, historians say that is at best an oversimplification.

Some practices did cease, but this period also saw the production of spectacular metalwork, often using copper. "If everything was so terrible and dark, how come they're wearing these amazing brooches and they've got colourful bead necklaces?" says Kershaw. ▮

New Scientist Live

Fighting fake archaeology

See Flint Dibble discuss how to fight pseudo-archaeological narratives on 18 October **newscientist.com/nslmag**

Zoology

'Great Migration' of wildebeest is smaller than we thought

EAST Africa's "Great Migration" is generally estimated to involve as many as 1.3 million wildebeest. But in reality, fewer than 600,000 of the animals might move across the Serengeti Mara landscape each year.

The Great Migration sees wildebeest, zebra and antelope move between feeding and breeding grounds in Kenya and Tanzania.

Assessing the number of animals involved is traditionally done using crewed aerial surveys. Researchers can survey only a small area at a time, however, so they use statistical models to extrapolate densities across unsurveyed regions.

DANITA DELIMONT/ALAMY

Every year, wildebeest move across the Serengeti Mara landscape in East Africa

Satellite surveys can help, because one photo can cover hundreds of thousands of square kilometres. It is impractical to manually count wildebeest in such vast images, but they can be tallied using AI instead.

Isla Duporge at the University of Oxford and her colleagues trained two deep-learning models – U-Net and YOLOv8 – to identify wildebeest using a dataset of images in which 70,417 of the animals had been manually labelled. Both models were then applied to more than 4000 square kilometres of high-resolution satellite imagery, captured on 6 August 2022 and 28 August 2023.

The two models gave similar results, counting 324,202 and 337,926 wildebeest in 2022, and 502,917 and 533,137 in 2023 (*PNAS Nexus*, doi.org/p5kc).

Lower counts don't necessarily mean wildebeest populations have collapsed. They may have altered their migration routes. But they do face major challenges, and accurate population estimates are crucial for informing conservation efforts. ▮

Graeme Green

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Zoology

Surprising number of mammals are iridescent

Jake Buehler

JABRUSON/NATURE PICTURE LIBRARY/ALAMY

Golden moles were thought to be the only mammal that shimmers

MORE than a dozen mammal species shimmer and glint purple and green, like precious opals. Their fur is iridescent, meaning its colour appears to change depending on the animal's orientation relative to the viewer – and this effect is more common than we thought.

Jessica Leigh Dobson at Ghent University in Belgium was studying colour in mammals using specimens at the Royal Museum for Central Africa, also in Belgium, when she noticed an electric blue glint on the fur of a tropical vlei rat (*Otomys tropicalis*).

"I immediately headed back to the office to see if it was documented anywhere, because everything I'd read up to then had been telling me [mammal] iridescence is only found in golden moles," says Dobson. Golden moles are African burrowing mammals more closely related to aardvarks and elephants than true moles, their name derived from their tinsel-like hairs.

Dobson found casual mentions of other mammal species' shiny fur dating as far back as the 1890s. So, she and her colleagues examined the fur on specimens of mammals associated with anecdotal reports of iridescence – or that were closely related to species with such reports. They used a light microscope to shine light on the fur at differing angles and analysed the wavelengths – and therefore the colours – of the light reflected off the hairs.

The analysis revealed that an additional 14 mammal species have iridescent coats, including 10 rodents and the giant otter shrew (*Potamogale velox*), a semiaquatic predator that is neither otter nor shrew (*Journal of the Royal Society Interface*, doi.org/g927zd). Six of these species had never previously been considered iridescent in the scientific literature.

When the researchers looked at the hairs of these iridescent mammals under a high-powered microscope, they found they were all unusually smooth, each made of a series of sub-parallel layers that were more highly compressed than the layers inside typical mammalian hair.

The researchers think the shininess is probably a by-product of other hair-based adaptations. It could, however, serve other functions, perhaps for visual communication, as is the case in many birds, says Dobson. ▮

Health

Antibody mix may be universal flu treatment

Chris Simms

A COCKTAIL of antibodies could give us a new weapon to fight flu.

Most flu treatments and vaccines prompt the body to make neutralising antibodies. These bind to specific strains of a virus, stopping it from infecting cells. This can be very effective, but may take months to develop and can lose effectiveness if the virus mutates.

Silke Paust at the Jackson Laboratory in Farmington, Connecticut, and her colleagues are focusing on non-neutralising antibodies instead. These proteins have largely been ignored for fighting infectious diseases because they don't prevent infection. Instead, they empower the immune system to kill the virus responsible by tagging already infected cells.

"We are trying to create a drug that you can give after infection to prevent severe disease"

"We are making a therapy, not a vaccine. What we are trying to do is create a drug that you can give prophylactically or therapeutically after infection to prevent severe disease and death," says Paust.

Paust and her colleagues focused on antibodies that would target an influenza virus protein in a region called M2e, which is essential for the virus to replicate itself and is nearly unchanged in all flu strains.

The researchers conducted a series of experiments in which they tested how well the antibodies worked individually or in combination in mice that were infected with a flu virus, and found that combining three antibodies gave the best results.

They tested the cocktail in mice exposed to two strains of H1N1 influenza, including the one that caused the 2009 swine flu pandemic and gave rise to the currently circulating H1N1, and two avian influenza strains: H5N1, which is infecting wildlife around the world and some livestock in the US, and H7N9, which can be deadly to both humans and other animals.

The researchers found that the cocktail reduced disease severity and the amount of virus in the lungs, and it improved survival rates in both healthy and immunocompromised animals (*Science Advances*, doi.org/p5kr).

For H7N9, all the mice survived when given the treatment in the first three days after infection, 70 per cent survived if treated on day four and 60 per cent if treated on day five.

It is the first time we have seen such broad protection against flu in living animals, says Paust. The cocktail also worked when given before infection, so could be used to prevent illness.

After 24 days of treatment, there were no signs of the virus successfully mutating to resist it.

"This shows how a cocktail of antibodies might be utilised as a drug to treat people during a flu pandemic," says Daniel Davis at Imperial College London. "But this would need to be tested in humans before this can be considered a true medical advance." ▮

New Scientist Live

A myth-busting guide to immune health

Hear more from Daniel Davis on 19 October at New Scientist Live newscientist.com/nslmag

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CURRENT ACCOUNT SWITCH GUARANTEE

Climate change

Polar geoengineering just won't work

A review of five methods put forward for cooling down the poles or slowing the loss of ice concludes they are all wildly impractical, wouldn't work, or both, finds **Michael Le Page**

WITH carbon dioxide emissions still increasing, can geoengineering halt the melting of the Greenland and Antarctic ice caps and prevent massive sea level rises? No, according to a review of the five main ideas for polar geoengineering proposed so far.

Promoting geoengineering ideas that cannot work distracts attention from the key issue,

"Promoting ideas that cannot work distracts from what we need to do, which is to decarbonise"

says Martin Siegert at the University of Exeter in the UK. "It becomes something that is working against what we need to do, which is to decarbonise."

Siegert and his colleagues assessed each idea based on six criteria: will it work, can it be done at the scale required in a reasonable time, is it affordable, will countries agree to it and be able to maintain that agreement for many decades, what are the environmental risks, and will it raise false hopes (*Frontiers in Science*, doi.org/p5gj)?

In Antarctica, some ice sheets rest on the seabed and are being melted from below by warming ocean waters. One proposed idea to save them is to build immense "curtains" to stop warm currents from reaching these ice sheets and the floating ice shelves that help protect them.

It isn't clear if this would help, says team member Steven Chown at Monash University in Australia.

"Warm water may well be diverted from one ice shelf, but the question is where does it go to? It may well just go to the ice shelf next door, creating a different problem," he says.

Such curtains would have to be anchored to the seafloor at depths of up to 1 kilometre,

STEVE ALLEN TRAVEL PHOTOGRAPHY/ALAMY

The melting of the Greenland ice cap is leading to rising sea levels

extend upwards for hundreds of metres and stretch for tens of kilometres at least – and they would have to be built in an extremely challenging environment, says Chown.

With glaciers that sit on land, the worry is warming temperatures are resulting in more liquid water underneath the ice, which acts as a lubricant that speeds up the ice flow. More ice reaching the sea means more sea level rise.

So another proposal is to drill holes down through the ice to pump out all the water underneath them.

"This would require a large amount of holes through extremely deep – possibly kilometres thick – areas of ice that's far beyond any scientific drilling project that's ever happened," says team member Sammie Buzzard at Northumbria University in the UK.

We don't even know where the water is and where to drill. "But even if we understood where to drill better, we still have the scalability problem, the cost problem, the problem of powering that drilling," Buzzard says.

Reflecting sunlight

A third idea is to cover the surface of the Arctic Ocean with tiny, hollow glass beads to reflect more of the sun's heat back into space and cool the region.

Maintaining this cover would require 360 megatonnes of glass beads to be produced each year, which is the equivalent of the total global production of plastic. A project aiming to try the idea was shut down after lab tests showed the beads were toxic.

Then there is stratospheric aerosol injection – releasing substances such as sulphur dioxide into the stratosphere to form aerosols that reflect sunlight. This is much more problematic over the poles than elsewhere. Aerosols don't remain in the polar stratosphere for as long as over the tropics, say, and they make little difference during dark polar winters, or above reflective ice or snow.

As such, very large quantities of aerosols would be required. This could deplete the ozone layer and disrupt the climate elsewhere, says team member Valérie Masson-Delmotte at Paris-Saclay University in France.

Some have suggested thickening the sea ice in the Arctic by pumping seawater on top of it. "This would require millions of devices deployed across drifting, fracturing ice," says team member Heïdi Sevestre at the Arctic Monitoring and Assessment Programme in Norway. "This is technologically, logistically and financially unrealistic."

The final idea the researchers assessed is fertilising the Southern Ocean to boost phytoplankton growth, which removes carbon if more organic matter is locked away in sediments on the seafloor. But across 12 small trials, more carbon reached the seafloor in only one. And this approach could accelerate oxygen loss in the oceans, potentially increasing the release of potent greenhouse gases such as methane and nitrous oxide, says Masson-Delmotte.

Not all researchers are convinced, however. "I don't think enough is known about any of these approaches for them to be taken off the table," says Shaun Fitzgerald at the Centre for Climate Repair in Cambridge, UK. ▮

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Space

Exoplanet shows signs of having a habitable atmosphere

Matthew Sparkes

THERE are promising signals that one of the planets in the TRAPPIST-1 star system, which lies about 40 light years from Earth, has an atmosphere capable of supporting life. But scientists will need to image it 15 times more to make sure.

TRAPPIST-1 is a small red dwarf star with at least seven planets. It was discovered in 2016 and immediately became a target of astronomers hoping to detect extraterrestrial life because three of these worlds lie within the so-called Goldilocks zone, where water remains liquid.

However, subsequent imaging of three of its exoplanets, including two of the three within the Goldilocks zone, left the field disappointed when no atmosphere was detected around any of them. But Ryan MacDonald at the University of St Andrews, UK, and his colleagues have focused on TRAPPIST-1e, right in the middle of the Goldilocks zone, and believe they have reason for optimism.

MacDonald and his team used the James Webb Space Telescope to scan TRAPPIST-1e in 2023 and have been working since then to extract a better picture of the world. Astronomers gather information on whether a distant exoplanet has an atmosphere by capturing images of the world as it passes in front of its star. Analysing subtle alterations to the starlight can reveal which chemicals are present in any atmosphere – and whether they include those that may be conducive to life.

But because TRAPPIST-1 is a red dwarf, it is much cooler than our own sun, making the readings more complex. For instance, chemicals like water that could indicate a hospitable atmosphere might actually be present in the star itself, meaning that signatures from TRAPPIST-1e's atmosphere had to be disentangled from those of the TRAPPIST-1 starlight that was shining through it. This demanded new models and years of work. The preliminary results suggest TRAPPIST-1e has a life-friendly, nitrogen-rich atmosphere, potentially marking a significant moment in the search for life beyond Earth (*The Astrophysical Journal Letters*, doi.org/p5gd).

"If it is habitable, just imagine what's happened on that planet for the last 7.6 billion years"

"Of all the spectra we have obtained so far of the planets in the TRAPPIST-1 system, this is the one that's the most promising, that's pointing towards there potentially being something there," says MacDonald.

"Obviously, I'm hoping that the planet right in the middle of the habitable zone of this star has an atmosphere, because that would have incredible implications for astrobiology, our search for life and habitability."

MacDonald says that if the presence of a nitrogen-rich atmosphere is confirmed with subsequent data, the next step would be to look for gases like methane or carbon dioxide and work out using climate models what the temperature at the surface is likely to be and whether that would allow for liquid water.

But the researchers stress more data is needed. So far, they have data from four JWST observations, but over the next year, they hope to carry out 15 more.

Matthew Genge at Imperial College London says that there is no shortage of exoplanets being discovered, but that astronomers are keen to find any that have the right conditions for life.

"If [TRAPPIST-1e] is habitable, just imagine what's gone on on that planet for the last 7.6 billion years," says Genge. "The older the planet is, then the more likely that I would say it is for intelligence to actually evolve." ▮

Archaeology

Sculpted head may reveal a unique ancient hairstyle

A MINIATURE statue from northern France dating back 27,000 years may give us clues to how ancient hunter-gatherers styled their hair.

The statuette was unearthed in 2021 from an open-air site about 140 kilometres north of Paris called Amiens-Renancourt 1, but has only just been described by scientists.

It has long hair that appears to be braided with a gridded pattern, which could represent hair netting or a unique hairstyle. This differs from statuettes found across central and eastern Europe, where the hairstyle or headpiece is shorter and covers most of the head, says Olivier Touzé at the University of Liège in Belgium, who wasn't involved in the study.

STEPHANE LANCELOT/INRAP

This statuette, discovered in France, depicts a person with long, braided hair

"This could be a cultural particularity that would never have been highlighted other than through these rare human representations," says team member Clément Paris at France's National Institute of Preventive Archaeological Research.

Radiocarbon dating of rock layers at Amiens-Renancourt 1 suggests the figurine is around 27,000 years old, making it part of the Gravettian period, which lasted from 33,000 to 26,000 years ago across Europe (*Journal of Archaeological Science: Reports*, doi.org/p5gg).

Other excavations at the site unearthed several scrap fragments and more than a dozen additional figurines, including Venus figurines that represent women. "It appears that the site had a workshop dedicated to [statuette] production," says Touzé.

But questions remain about the statuette and the people who made it. "Thoughts and myths from prehistoric times leave few traces," says Paris. "And when we do have traces, such as this statuette, their meaning remains enigmatic." ▮

Taylor Mitchell Brown

Views

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Without empathy, AI drivers won't do a jot for road safety p35

Comment

Sustainability over style

A radical idea to standardise packaging across brands could make it far easier for us to recycle and reuse plastic, says **Saabira Chaudhuri**

EVER since the US-based National Biscuit Company launched the first branded consumer package in 1899 – putting its Uneeda soda crackers in waxed paper inside a cardboard box – brands have seen packaging as a marketing tool. From the 1950s onwards, as companies increasingly switched to using plastic, competition accelerated and packaging became the best way to signal a distinct identity – picture Tide's orange detergent jug or Heinz's squeezy ketchup bottle.

But as brands added a growing array of pigments, materials, and other complexities, the already fragile economics of plastics recycling collapsed. Just 10 per cent of plastic packaging is recycled globally. Meanwhile, reusable packaging remains niche.

There is a simple yet powerful way to improve both plastics recycling and reuse – make brands use similar packaging for products in the same category.

Let's take recycling first. Even with decades of consumer education and investment in infrastructure, it is too expensive to sort much plastic packaging into individual subtypes. Pigments can't be eliminated and sorting by colour is expensive, so much coloured plastic gets downcycled into grey pipes or building material. Supply is inconsistent and fragmented, and virgin plastic is invariably cheaper, so reliable buyers for most used plastics don't exist.

Standardisation could dramatically improve things. If product categories followed uniform guidelines for plastic type, colour, labels and adhesives, recyclers could cheaply recover far more material. This could finally make recycling economically viable and help achieve the dream of "circularity", in which a new bottle is made from an old one.

ELAINE KNOX

The case for standardised reuse systems is as compelling. Today, the few brands experimenting with reuse mostly use different containers. These need individual return points alongside custom washing equipment and quality checks, which increase expense and complexity while reducing convenience. Reuse systems based on standardised packaging and shared infrastructure could capture 40 per cent of the market, versus 2 per cent under a fragmented approach, according to the Ellen MacArthur Foundation.

Standardised packaging may sound like an assault on capitalism to some, but brands already produce similar packaging for milk jugs in the UK and for toothpaste tubes in many countries. And standardised packaging wouldn't mean that all products have to be identical. Brands could still use labels, washable inks, embossing and other techniques to differentiate themselves. They could also still use their own shapes and sizes of packaging, so long as these don't impede sorting.

Admittedly, it is hard to imagine rivals like Procter & Gamble and Unilever voluntarily agreeing to put their shampoo in the same-coloured bottles. But as data mounts about the billions of dollars lost each year from single-use plastics that are burned or landfilled – and research sheds more light on the health risks linked to thousands of poorly studied chemicals in plastics – brands may find their corner is harder to defend. Legally, it could be argued that the damage caused by bespoke packaging outweighs any harms caused to brands from standardised containers.

Increasingly, brands may not have a choice. In Europe and other parts of the world, policy is already requiring reuse targets and the use of more recycled content. Standardised packaging offers brands a path to meet such goals while sidestepping a jump in complexity and costs.

Similar shampoo bottles won't solve everything, of course. But such changes increasingly look like good business sense. Without them, truly circular packaging remains a distant dream. ▮

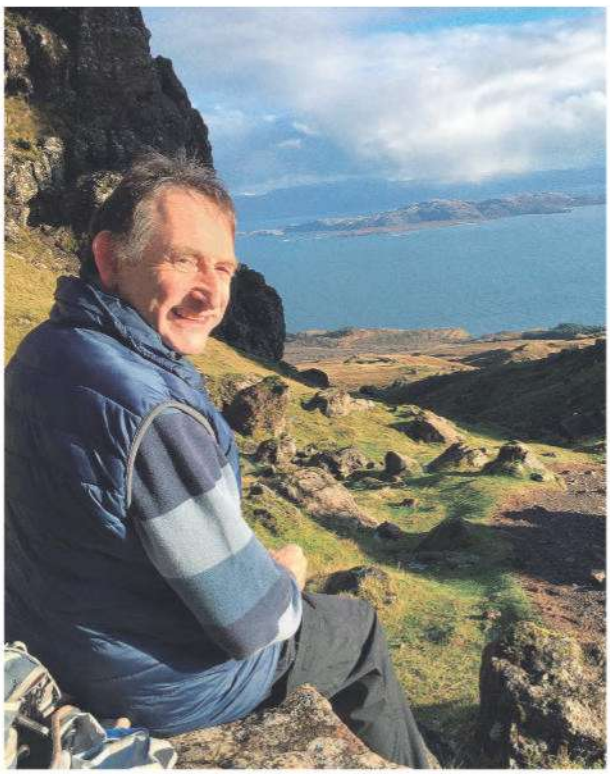
Saabira Chaudhuri is the author of *Consumed: How big brands got us hooked on plastic*

People can be a happy place. **Jo's** four children are his. His world is never bigger than with them. Out on a hike. Everyone together. It's when Perthshire is at its most beautiful.

But his favourite bit? When the walk is finally over and the whole family sits down for a proper cup of tea and ever-so-slightly overdone fruit cake.

It's what made his late wife, Sue, happiest. The brood of kids all around her. Stomachs and hearts full. And it's the part he now cherishes most.

That's why he left a gift to Cancer Research UK in his Will.



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This changes everything

In the long run

We are still waiting for the retro-futuristic tech envisioned in science fiction stories of years past – including advances in human reproduction, writes **Annalee Newitz**

Annalee Newitz is a science journalist and author. Their latest book is *Automatic Noodle*. They are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading
Cannupa Hanska Luger's Surviva: A future ancestral field guide*, a sci-fi art book about the Indigenous technologies of tomorrow.*

What I'm watching
The Legend of Vox Machina*, a delightfully foul-mouthed* Dungeons & Dragons *adventure anime.*

What I'm working on
Helping the plants and fungi to live in harmony in my garden.

This column appears monthly. Up next week: Rowan Hooper

THERE is a game some people like to play when thinking about the future. Call it "Where's my jetpack?" We pore over science fiction from years past (often the years when we were impressionable kids) and ask: "Why didn't we get all the cool stuff we were promised?" Sure, we got videophones, pocket-sized computers and robots on Mars, not to mention genetically engineered bunnies that glow in the dark. But what about jetpacks? And flying cars?

It is always something. That one image or idea that became synonymous with "the future", but now lives in the ashtray of history. And yet people will cling to it, trying to make jetpacks happen because the idea still seems, frankly, pretty cool.

When I play Where's my jetpack, however, I don't ask about what happened to all those gadgets. Instead, I ask: "Where are the social revolutions I was promised when I was a kid?"

For me, that will always be the 20th-century idea of a revolution in gender equality. Audiences devoured stories about how the men and women of tomorrow would be swapping gender roles in completely unexpected ways. But now that vision of freedom seems as retro as Flash Gordon.

I recently discussed this with a group of writers on a panel about retro-futurism at science fiction convention WorldCon. Since then, I have been pondering the power of ideas from history about the future.

Science fiction authors dreamed of women's equality at least as far back as 1915, when Charlotte Perkins Gilman published the novel *Herland*. In it, a group of male adventurers discover a country ruled by women, who live in a utopian society that bears some resemblance to Wonder Woman's beloved Themiscyra.

Much later in the century, in 1974, the cult classic movie *Zardoz* imagined a distant future of free love, where men could marry each other. Anyone who has seen this wild movie will never forget Sean Connery donning a lacy wedding gown to marry a man in a high-tech hippie ceremony.

Women now have the vote in most countries, and men can marry each other in many places, too. But other cultural revolutions exist in the same wishful limbo as the jetpack.

> **"Anyone who has seen *Zardoz* will never forget Sean Connery donning a lacy wedding gown to marry a man"**

Consider, for instance, male pregnancy. No, really. You would be surprised how often this trope comes up in science fiction.

Perhaps most famously, it is the plot of 1994 science fiction comedy *Junior*, where we learn that truly advanced science has allowed the world's most famous action movie hero, Arnold Schwarzenegger, to get pregnant and give birth.

But this idea is also floated in the classic 1970s feminist novel *Woman on the Edge of Time* by Marge Piercy, where children are incubated in artificial wombs and people of all genders can breastfeed them.

My personal favourite is the genuinely excellent 1985 war movie *Enemy Mine*, about an improbable, interstellar, interspecies friendship between a pregnant male alien and a regular old human bro after they crash-land on an inhospitable planet.

Just as jetpacks are ubiquitous in science fiction of a certain era, so, too, is male pregnancy. Those novels weren't entirely wrong. We do indeed have pregnant men (there are plenty of documented examples), and there are DIY jetpack enthusiasts, too. But neither group is as widespread as pop culture led us to believe they would be.

So why were so many fantasies about male pregnancy birthed in the late 20th century?

Partly it was the result of the sexual revolution, which inspired people to question their traditional ideas about sex and families. If women could achieve equality in the male-dominated workplace, after all, why shouldn't men achieve equality in the realm of motherhood?

Then along came the unmistakable influence of the LGBTQ+ rights movements. As the century ended, the idea of a "chosen family" had hit the mainstream, and science fiction authors were speculating about families with two dads, three mums, or four robots and an octopus.

And why not? As long as the kids have a happy, stable environment, who cares if dad is the one who gets pregnant?

Back in the 1990s, Schwarzenegger allowed men to dream that they could experience the miracle of bearing a child.

But in 2025, US President Donald Trump issued an executive order stating that there are only two genders, and that they are immutable. Whatever was scribbled on your birth certificate is your inescapable destiny. Women get pregnant and men don't.

It doesn't matter what they say. You might still be waiting for your jetpacks. I'm still waiting for my pregnant men. ▮

Slow escape

Garry Lotulung
YIARI animal rescue

THESE photos tell an unusual rescue story – the release of Javan slow lorises into Ujung Kulon National Park on Java Island, Indonesia, last month.

Photojournalist Garry Lotulung joined a team from the Indonesian branch of International Animal Rescue, the non-profit Yayasan Inisiasi Alam Rehabilitasi Indonesia (YIARI), as they released Javan slow lorises, transporting the animals on their backs (upper near left).

The Javan slow loris (*Nycticebus javanicus*) is critically endangered, as a result of the destruction of its rainforest habitat and its capture for sale as pets or for body parts in traditional medicine. These animals often have their teeth removed to stop them from biting, which means they can't feed in the wild. But if the rescued animals can look after themselves, YIARI releases them into the wild.

Slow lorises look cute – but they are the world's only venomous primate. When threatened, they raise their arms above their head and take a secretion from glands on their arms into their mouths. The secretion forms venom when combined with saliva.

This two-step system is unique to slow lorises. While the nature of the venom isn't fully understood, their bites are painful, slow to heal and can cause allergic reactions. Spread on their fur, the venom may also protect the animals from parasites such as ticks and fleas.

These animals were given vitamins (lower near left) and then placed in an enclosure (upper far left) for monitoring (lower far left). "They are monitored for several days to two weeks to ensure they can survive in the wild before being permanently released," says Lotulung.

Michael Le Page

Common knowledge

Steven Pinker makes a compelling case that knowing what everyone else knows transforms societies. But **Michael Marshall** laments his politics

Book

When Everyone Knows That Everyone Knows

Steven Pinker

Allen Lane (UK); Scribner (US)

Out 23 September

JEAN-CHRISTIAN BOURCART/GETTY IMAGES

Steven Pinker argues that "cancel culture" is a form of censorship

STEVEN PINKER'S new book perfectly encapsulates what a contradictory figure he has become. Much of it is a clear, fascinating explanation of a major psychological phenomenon. But then he starts telling you what he thinks about current affairs.

Pinker is a psychologist at Harvard University who has written a string of popular science books. Some, like *Words and Rules*, are rooted in his own research and are a good read. Others venture further afield, such as *The Better Angels of Our Nature*, which argues there has been a long-term decline in violence in human societies.

The books in the latter category have become massive bestsellers, but they have also been kicked around by reviewers arguing that Pinker is way out of his depth. In *The Better Angels of Our Nature*, he had to confront the obvious exception to the trend of declining violence: the 20th century, which saw two world wars, the Holocaust and much more. To address this, he cherry-picked statistics to suggest previous centuries saw higher death rates, and also proposed that the 20th century was a historical fluke, claims that met with stiff criticism.

So I approached Pinker's latest book with some wariness. Which side of him would be on display: the thoughtful psychologist, or the overconfident pundit? Both, it turns out. His topic is "common knowledge": things that everyone knows and, crucially, we all know that everyone knows. He neatly illustrates its importance through Hans Christian Andersen's *The Emperor's New Clothes*, in which a child innocently – and correctly – points out that the emperor is naked. As Pinker writes, "he wasn't telling anyone anything they didn't already know", but he added to their knowledge, ensuring "that they now knew that everyone else knew what they knew". That was enough for the crowd to start laughing.

Common knowledge can be transformative. Pinker imagines an oppressed population and an authoritarian government. If enough people protest, the regime will fall, no matter how many guns it has. But it is difficult to begin: if no one joins your protest, you may be massacred. You know that the government is awful, but does everyone else? And do they know that everyone knows? Only with common knowledge can people confidently take to the streets.

"It is akin to writing about the criminal justice system by only telling stories of miscarriages of justice"

In *The Emperor's New Clothes*, a child says what everyone privately knows

The first seven chapters develop this idea in detail, using examples from game theory and psychology. Pinker is a graceful and clear writer, and he does a good job of guiding readers through various tangled logic puzzles, even using cartoons and a famous exchange from *Friends* ("They don't know that we know they know we know!").

Occasionally, he makes an asinine aside. He remarks, for instance, that a logic puzzle was first published "in the politically innocent early 1950s", which is a bizarre way to describe the era of the second Red Scare. Still, these are minor annoyances.

But then, in chapter eight, which traces the psychological roots of "cancel culture", everything goes to hell. His argument is that cancel culture is a form of censorship, motivated by "the urge to prevent ideas from becoming common knowledge". It might be OK if people privately believe that one ethnic group is inferior to another, he suggests, but if this became common knowledge, it would lead to discrimination. Hence the urge to crack down on those who share such sentiments publicly.

There might be something to Pinker's analysis of what drives people to cancel, but it is impossible to tell because his discussion of cancel culture is so poor. All his examples come from the liberal left, but the right also cancels: such was the fate of the Chicks (formerly the Dixie Chicks), who opposed the 2003 invasion of Iraq. And he never considers cases of people cancelled for genuine harms, which is analogous to writing about the criminal justice system by only telling stories about miscarriages of justice.

The final chapter covers how we decide whether to keep something semi-private or make it common knowledge. Pinker concludes that it depends on specifics. Thank heavens you're here, Steven. When he sticks to psychological research, he is fascinating. It is a shame he wanders off course. ▮

Michael Marshall is a writer based in Devon, UK

Stopping an AI apocalypse

We must take drastic action before superintelligent AIs wipe out humanity, according to a new book. **Jacob Aron** isn't convinced

Book

If Anyone Builds It, Everyone Dies

Eliezer Yudkowsky and Nate Soares

Bodley Head (UK); Little, Brown (US)

IN THE totality of human existence, there are an awful lot of things for us to worry about: money troubles, climate change, finding love. But for some, one concern rises above all others: that artificial intelligence will eventually destroy the human race.

Eliezer Yudkowsky at the Machine Intelligence Research Institute (MIRI) in California has been proselytising this cause for a quarter of a century. His new book *If Anyone Builds It, Everyone Dies*, co-written with his MIRI colleague Nate Soares, successfully distils this argument into a simple, easily digestible message that will be picked up across society. The problem is that, while compelling, their argument is fatally flawed.

Things start to go wrong around chapter three, in which the pair describe how AIs will begin to behave as if they "want" things, while skirting around the question of whether we can really say a machine can "want". They refer to a test of OpenAI's o1 model, which completed an accidentally "impossible" cybersecurity challenge, pointing to the fact that it didn't "give up" as a sign of the model behaving as if it wanted to succeed. I find it hard to read any kind of motivation into this scenario – if we place a dam in a river, the river won't "give up" its attempt to bypass it, but rivers don't want anything.

The next few chapters deal with what is known as the AI alignment problem, arguing that once an AI has "wants", it will be impossible to align its goals with those of humanity, and that a superintelligent AI will ultimately want to consume all possible matter and energy to further its ambitions.

Sure – but what if we just switch it off? For Yudkowsky and Soares, this is impossible. Their position is that any sufficiently advanced AI is indistinguishable from magic (my words, not theirs) and would have all sorts of ways to prevent its demise. They imagine everything from a scheming AI paying humans to do its bidding (not implausible, I suppose, but again we return to the problem of "wants") to an AI discovering a previously unknown function of the human nervous system that allows it to directly hack our brains. (I guess? Maybe? Sure.)

If you invent scenarios like this, AI will naturally seem terrifying. So, what should we do? The pair have a number of policy prescriptions, all of them basically nonsense. They say it should be illegal to own more than eight of the top 2024-era graphics processing units, the computer chips that have powered the current AI revolution, without submitting to nuclear-style monitoring by an international body. (For reference, Meta has at least 350,000 of these chips.) Once this is in place, they say, nations must be prepared to enforce these restrictions by bombing unregistered data centres, even if this risks nuclear war.

Take a deep breath. How did we get here? For me, this is all a form of Pascal's wager. Mathematician Blaise Pascal declared that it was rational to live your life as if God exists. If God does exist, believing sets you up for infinite gain, while not believing leads to infinite loss in hell. If God doesn't exist, maybe you lose out a little from living a pious life, but only finitely so. Similarly, if you assume that AI leads to infinite badness, pretty much anything is justified in avoiding it.

It is this line of thinking that leads some to argue that any action in the present is justified as long as it leads to trillions of happy humans in the future. Frankly, I don't understand how anyone can think like this. People alive today matter. Billions of us are threatened by climate change, a subject that goes essentially unmentioned in *If Anyone Builds It, Everyone Dies*. Let's consign superintelligent AI to science fiction, where it belongs, and devote our energies to solving the problems of science fact here today. ▮

The rise of artificial intelligence has increased demand for data centres like this one in London

JASON ALDEN/BLOOMBERG VIA GETTY IMAGES

New Scientist *recommends*

Bethan Ackerley
Assistant culture editor London

David Attenborough has given us another wonderful nature doc this year, **Parenthood** on BBC iPlayer. You might expect this five-parter to be soft and fuzzy, given

the subject matter. While that can be true – the competition for cutest baby animal is fierce – there is plenty of horror, too. For example, did you know that a female African social spider will make the ultimate sacrifice by letting her offspring eat her alive?

The series doesn't shy away from the effects of climate change and agriculture, either: we get bleak insights into the suffering of animal parents, from hippos to demoiselle cranes. Watch lionesses teach muddy cubs to cross the waterlogged savannah after a rare rainfall to hunt prey, with heartbreaking consequences. For light relief, discover unusual hacks, such as the "poo bags" scooped up by swamp canary parents.

And yes, dads may get involved too, including a Tom Cruise-esque dart frog and a zebra so noble you'll wish he'd raised you.

BBC/SILVERBACK FILMS/AARON SANDHU

The sci-fi column

A literary mystery Set in a future where rising seas have swallowed most of the UK, Ian McEwan's excellent novel *What We Can Know* follows a scholar on a quest to rediscover a great lost poem, says **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist* and the author of the *Sumerians* trilogy, set in ancient Mesopotamia. The final novel in the series, *Ninshubar*, is out now. You can find her at emilyhwilson.com, or follow her on X @emilyhwilson and Instagram @emilyhwilson1

WESTEND61/GETTY IMAGES

In *What We Can Know*, large swathes of the UK are underwater

Book

What We Can Know

Ian McEwan

Jonathan Cape (UK); Knopf (US)

Emily also recommends...

Book

Briefly Very Beautiful

Roz Dineen

Bloomsbury (UK); The Overlook Press (US)

This novel, first published last year, paints a very different picture of the UK after severe climate change. Dineen imagines a hot future, rather than a drowned one. But, like What We Can Know, *the novel also deals with powerful themes of intimacy, memory and loss.*

THE latest novel by Ian McEwan, *What We Can Know*, is an extraordinary piece of work that defies neat categorisation.

The story is largely narrated by a man named Tom Metcalfe, an academic at the University of the South Downs, UK, in the year 2119. The seas have risen dramatically, and only the highlands of the UK remain above water. For Tom to travel to, say, the Cotswold Islands, he must hire a boat and a captain. Marlborough is now a port, and a journey to as far north as what used to be the Lake District is out of the question, thanks to pirates.

The world is transformed; life is frugal. There are far fewer people, though they are crowded together on scraps of remaining land. The profligacy of the "Derangement", as the long period before the seas rose is now called, has vanished.

However, this future world is only one strand of the book. Tom is a historian, and what he is particularly interested in, as it happens, is something very specific: a dinner party given in 2014, long before climate change hit the UK hard. He is interested in all the people who attended that soirée, and the allegedly great poem that the host, a poet called Francis Blundy, read to his guests that evening.

Hence, the second strand of this novel is a deep dive into that middle-class, literary-set dinner party – the sort of event you can well imagine McEwan attending in real life. That might sound like quite a stretch, but it made increasing sense to me as the book went on.

> **"No one outside the dinner party ever heard the poem, and no hard copy was ever circulated"**

Tom's reasons for digging ever deeper into that dinner are manifold. In the story, the poem read out that night went on to be held up as a great work that railed against climate change, and was said to have been suppressed by big oil. Yet no one outside the party ever heard it, and no hard copy was ever circulated. Was the poem about climate change or something else entirely? It is a literary mystery.

What's more, Tom has learned that for his students to become interested in the art of the past, they must first accept the artists of the past as real people. The only way to achieve that, he tells us, is to provide detail about the dead. So the lives of Blundy, his wife Vivien and their set matter deeply to him.

There is also a personal aspect to Tom's growing obsession with the Blundys. After years of study, he believes he has built up a portrait in his mind's eyes of everything that happened that fateful night, and he feels he now knows Vivien, in particular, very well indeed. He may even be in love with her.

Then Tom finds a clue that might lead him to the poem.

This novel won't be for everyone, but then, what novel is? I ended up absolutely loving it. It is sensationally well written, as you would expect from McEwan, and it is a very clever and thought-provoking book indeed, with many surprises contained within it. I failed to spot, or at least piece together, all of the clues laid out for me, so I was amazed by every twist.

I found *What We Can Know*'s depiction of our drowned future rather twinkling and magical: it had a bit of *Swallows and Amazons*, crossed with Hobbiton, to it. I also found the detailed and serious portrait of Vivien and the men in her life to be gripping.

The novel stayed with me for several days after I finished it. It makes you think about climate change and the denial thereof, love and deceit, how accurate histories can ever be, whether we can ever know another person's heart... among many other things! I thoroughly recommend it. ▮

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Editor's pick

At least human drivers are capable of empathy

23 August, p 21

From Matthew Stevens, Sydney, Australia

As a cyclist who has ridden in many cities and countries over the decades, I have learned not to trust any driver. But I have to disagree with Matt Sparkes in his hope that AI-controlled vehicles might reduce danger on the road. Drivers instinctively recognise me as a fellow human. There is no way an AI pilot, however sophisticated, will ever recognise a cyclist or a pedestrian as anything other than a matched pattern with the tag "avoid". An AI will simply follow instructions and make the least-worst decision. Unlike us, it can never identify with a human and ask: "If that were me, how would I feel?"

When you can't hear the bleeps anymore

23 August, p 27

From Elizabeth Schiralli, Wellsville, New York, US

I have just read your review of *Clamor*, a book about noise issues. It mentions the problem with medics not hearing the beeps from hospital machines after a while. I have a daughter with type 1 diabetes. She doesn't hear the beeping related to blood glucose sensors coming from her phone anymore. After spending a few days vacationing with her, I didn't, either. That's pretty scary!

It is hard being allergic to cheese but not milk

30 August, p 10

From Keith Appleyard, London, UK

I greatly appreciated your article on lesser-known food allergens. For some 70 years, I have experienced heart palpations and projectile vomiting when I eat cheese, but I don't have an adverse reaction to milk or yogurt. As cheese doesn't appear separately on the UK Food Standards Agency's list of allergens that must be highlighted on food labels, my condition is often ignored or met with scepticism.

I check ingredients carefully and err on the side of caution, but I nearly got caught out a few years ago with a sandwich that contained "Grevé". No one could tell me what it was at the time, but I later found out it was a Swedish cow's-milk cheese.

Right to free internet may cost more than thought

23 August, p 20

From Sam Edge, Ringwood, Hampshire, UK

I understand Merten Reglitz's argument that internet access should become a human right. However, spending the best part of half a trillion dollars on this wouldn't automatically give people access to clean water, enough food, basic healthcare or the means to make a decent living to pay for these things, which they might consider a higher priority.

A right to free internet would probably have to include the right to a reasonably up-to-date device and access to free electricity to power it, not to mention training. That is going to cost at least an order of magnitude more.

A more effective idea might be some form of right to a universal basic income. There is a lot of evidence that the rest – including internet access – would follow.

An answer for those who equate natural with better

30 August, p 19

From Dyane Silvester, Arnside, Cumbria, UK

It is very refreshing to read Sophie Attwood's comments around the (often unwarranted) assumption that "natural" materials are automatically better than "modified" or "synthetic" versions. My response to people telling me that something is "totally natural" in this context has always been: "So is arsenic, but it's still going to kill you."

Many types of infinity are lurking out there

9 August, p 28

From Guy Cox, Sydney, Australia

Your article on infinity deals with very large and very abstruse concepts of it. But what about smaller, everyday infinities?

The number pi is something we use often enough, but it can only be expressed accurately with an infinite series of digits. This doesn't make it large – we all know that 4 is a larger number. What are the ultrafinitists going to do about this? Are they going to redefine pi with a fixed number of decimal places?

From Ross Hawkins, Logan City, Queensland, Australia

Could it be that the number zero is another infinity? Does a perfect vacuum exist? Does absolute zero temperature really exist? It seems to me that both the physical and the mathematical worlds are bounded by at least two infinities.

A way to avoid being taken for granted

23 August, p 44

From Jane Pearn, Selkirk, Scottish Borders, UK

Regarding David Robson's piece on how bosses tend to exploit their loyal employees: in my career in the National Health Service, I often worked with newly qualified therapists who didn't feel they could say no to anything managers asked and were in danger of early burnout. I advised them to say: "Yes, I'd love to take that on. Instead of what?"

How to solve the rare-earth mineral problem

23 August, p 36

From John Kitchen, Kettering, Northamptonshire, UK

Almost all of the problems with the mining of minerals vital to renewable technologies like electric cars can be solved by newer technologies: zero-rare-earth magnets, zero-rare-earth electric motors, zero-lithium supercapacitors.

The only remaining requirement will be copper. It is even possible that a form of carbon could replace copper in many applications. ▮

Michael Kenward OBE, a former *New Scientist* editor, sadly passed away in August. Michael joined *New Scientist* in 1969 as technology editor after working as a research scientist at Culham Laboratory, UK. In 1979, he became editor, spending 11 years at the helm, where he steered the magazine to become more accessible and engaging for the general public, extended our international news coverage and launched our Australasian edition in 1988. He received an OBE in 1990 after working as a member of the Committee on the Public Understanding of Science. After leaving *New Scientist*, he continued to translate scientific concepts into easily understandable stories as a freelance writer, editor and editorial consultant. He will be missed by all who knew him.

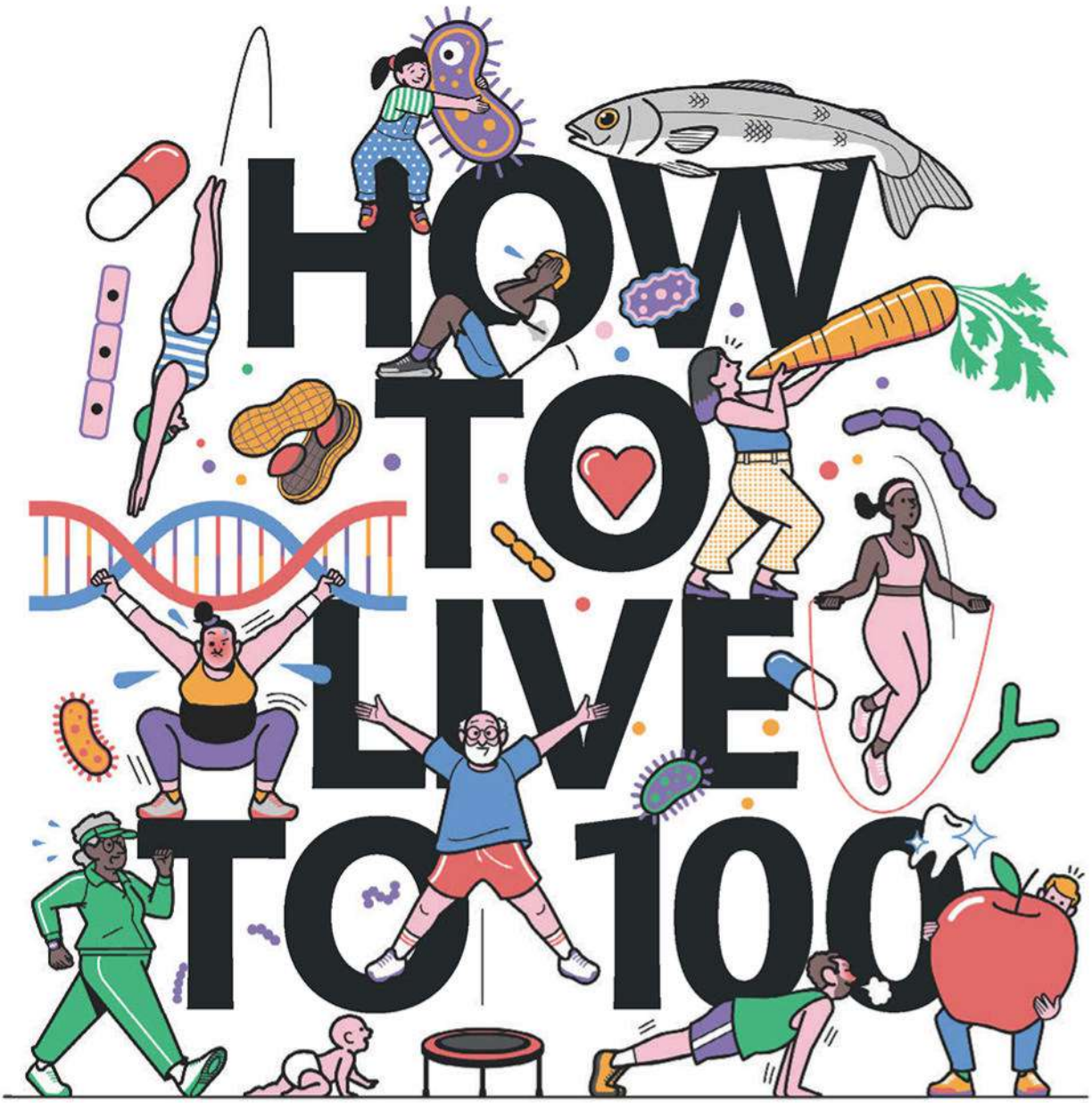
Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed

For the record

▮ **Jupiter's moon Ganymede could be used to detect large dark matter objects, which are likely to be composed of many particles (23 August, p 8).**



WE LIVE in an exceptional time in human history, with more people than ever now reaching the age of 100. What's more, the science of longevity is revealing the secrets of how to make the extra years as healthy and happy as possible. Of course, some factors – like genes – are out of our control, but habits and lifestyles can extend our lives by decades. Over the next 10 pages, discover how to vitalise and maximise your latter years – and get the inside story on how you can harness your diet, exercise, mindset and more to reach the centenarian club in style.

THE EXERCISES THAT WILL HELP YOU LIVE LONGER

"MY SECRET is that I never get off the sofa," said no centenarian, ever. But it is worth noting that the world's oldest people rarely mention punishing fitness regimes, either. Instead, centenarians tend to report a lifetime of regular, moderate exercise, such as walking, farming and gardening.

This exact prescription doesn't fit well into many modern lifestyles, but that hasn't stopped scientists from trying to identify the optimal dose and type of exercise for a long, healthy life.

What is clear is that doing nothing isn't an option. Lack of physical activity has been linked to at least 3.9 million premature deaths globally per year, and it significantly increases the risk of chronic illnesses, including heart disease, stroke and some cancers. On the flip side, getting enough exercise can add up to seven years to your life, while also extending the time you spend in good health.

A rough guide to how much is enough can be found in our evolutionary history. Modern hunter-gatherers, the closest we can get to how our ancestors lived, take around 11,000 to 20,000 steps per day, and get their resistance training from hunting, climbing, digging for tubers and carrying the resources they collect home.

They have lower rates of chronic diseases seen in Western nations, and the reason seems to lie in the body's response to all this work, which results in a surge in internal maintenance and repair. Harvard University evolutionary anthropologist Daniel Lieberman speculates that the reason exercise and physiological upkeep are linked is that evolution tied the two together, so that the genes involved in body repair and maintenance are activated only when we move. If we don't, the body saves energy by letting these functions slide.

SAM PEET

"Getting enough exercise can add up to seven years to your life, while also extending the time you spend in good health"

Because of the "use it or lose it" aspect of this, a growing number of researchers see exercise not as an "anti-ageing" strategy, but as a way to reverse the life-shortening and illness-inducing effects of a chronic lack of movement, potentially adding healthy years to our lives. "Exercise is one of those strategies that we can adopt in order to optimise the rate at which we decline," says Norman Lazarus, emeritus professor of exercise physiology at King's College London.

So how much will do the trick? Lazarus says that the World Health Organization's (WHO) guidelines are a good place to start. Based on large epidemiological studies, these state that adults should do at least 150 to 300 minutes per week of moderate-intensity physical activity (exercise that leaves you able to talk, but not sing, such as brisk walking), or 75 to 150 minutes at vigorous intensity (running, or cycling in hilly terrain, which leaves you breathing hard and fast), plus strength training done at least two days per week. People aged 65 or over should do an extra strength session and add balance and mobility exercises.

Importantly, none of this has to be in the form of structured exercise. Anything that uses physical strength or raises the heart rate will do the job. And it doesn't all have to come in one session – there is some evidence that multiple workouts are just as effective as longer, more structured ones.

Mikel Izquierdo at the Public University of Navarra in Spain and lead author on a "global consensus" on exercise recommendations for healthy longevity, which was published in January, agrees that the WHO guidelines are a good guide to lowering disease risk and extending lifespan. But, he adds, they may not be enough to guarantee a sprightly old age. "The majority of studies supporting the WHO recommendations focus on reducing disease risk and mortality, rather than functional independence," he says. "The reality is that meeting the basic guidelines doesn't automatically translate into preserved autonomy, especially in populations over 65."

From middle age onwards, says Izquierdo, everyone should get serious about working on their muscle strength. From our 30s on, muscle mass starts to decline, with fast-twitch muscle fibres, those needed to stand up from a chair, for example, taking the biggest hit. If left ›

unchecked, this loss of strength and endurance can lead to problems with walking, standing and an increased risk of falls and dying of any cause for older people.

Multiple studies, for instance, have shown a link between weaker hand grip strength and a shorter lifespan. However, this doesn't mean you necessarily need to beef up your hands. Grip strength is a proxy for overall muscle strength because it is easy to measure and has been shown to correlate with strength in the major muscle groups, particularly the legs.

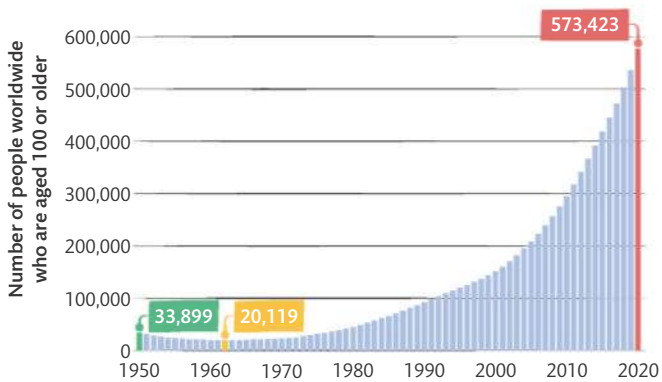
It is also a good idea to work on balance from middle age onwards. According to a 2022 study, people aged 51 to 75 who couldn't balance on one leg for 10 seconds were twice as likely to die within the following 10 years.

Bodyweight exercises such as squats and planks are a good place to start, says Izquierdo, but as muscle loss accelerates, the only way to stay one step ahead of this decline is to gradually increase the load by adding weights or using resistance bands.

Maria Fiatarone Singh, a geriatrician at the University of Sydney, also advises power training: jumping up stairs for those who are more agile, or doing fast leg presses in the gym at 80 per cent of the maximum weight a person can lift. This is because more explosive strength training builds up fast-twitch "type II" muscle fibres, which are the first to be lost during ageing.

Centenarian boom

More people than ever before are living to 100 and beyond.



SOURCE: WEFORUM

"From middle age onwards, everyone should get serious about working on their muscle strength"

It is never too late to start. Power and strength training have helped even frail people in their 90s build muscle, which in turn improved their ability to stand and walk independently. Intriguingly, even the intention to get stronger has some benefit, says Fiatarone Singh. Even if the weight doesn't move much at first, "it is the 'intent' to move fast which sends the message from the brain to the type II fibres to contract which optimally recruits them", she says.

So, all in all, there are many ways that we can fight against the physical decline of ageing. But we should also be realistic, says Lazarus, a keen cyclist who is approaching his 90th birthday.

There is only so much that exercise – or any other intervention – can do. "There are things happening to us over which we've got no control," says Lazarus. Maximal heart rate, for example – an estimate of the fastest rate that should be possible during exercise – is 220 minus age. "The formula doesn't say 220 minus age plus exercise, it says 220 minus time passing," says Lazarus. "You can exercise until the cows come home, you're not going to change that." Even elite athletes lose muscle mass, strength and cardiovascular efficiency with age, no matter how much they train.

"We are all going to die," says Lazarus. "You want to keep functioning as long as possible and die in a year. Not slowly over 40 or 50 years."

Or, as Izquierdo puts it, we should aim to "die young, as late as possible".

Caroline Williams

WHAT TO EAT TO ADD A DECADE TO YOUR LIFESPAN

ONE OF the standard questions put to centenarians is: "How do you do it?" The answers often revolve around food. For Maria Branyas Morera, who was the world's oldest person when she died last year aged 117, it was eating three yogurts a day. Jeanne Calment, officially the oldest person to have ever lived (though that has been disputed), put her amazing staying power down to olive oil, chocolate and the occasional glass of port.

Of course, what you eat matters. Diet has a huge influence on your health, and staying healthy is a prerequisite for a long life. But a better question might be: "What didn't you eat?"

For instance, Lars Fadnes at the University of Bergen in Norway and his colleagues have recently devised a longevity-enhancing diet, based on their analysis of a huge dataset called the Global Burden of Disease Study. This revealed, to no great surprise, that typical Western diets – high in refined grains, added sugars, red and processed meats and dairy products, and low in wholegrains, fresh fruit and vegetables, nuts and fish – aren't optimal for longevity. In fact, they are deadly, responsible for 11 million premature deaths a year.

The researchers modelled what would happen if people eating this diet switched permanently to a healthier one, and found a major impact on life expectancy. For example, a 20-year-old woman in the US today can expect to live to 80 on a typical diet eaten there. But if she drastically cut down on meat, sugar, dairy and refined grains and switched permanently to a diet of mostly wholegrains, fruit, vegetables, nuts, legumes and fish, her life expectancy would increase to 89 – a gain of nearly a decade. A 20-year-old US man making the same switch would similarly increase his life expectancy, albeit from a lower starting point, from 76 to 86.

"We gain a lot from increasing whole grains, nuts and legumes, and also reducing sugary foods and meats – processed and red meats in particular," says Fadnes.

And even if your 20th birthday is a long time ago, there are good reasons to still make the change. A 60-year-old US woman making the switch would gain more than seven extra years, increasing her life expectancy from 81.6 to 89. Even an 80-year-old gains a few extra years.

Fadnes also modelled what would happen if people switched to a diet halfway between a Western-style one and the optimal one. They still saw gains in life expectancy, albeit lesser ones.

These are theoretical models – a clinical trial of a longevity-promoting diet would take decades to deliver results. But there is real-world data to back the headline conclusion that diet has a big impact on health in later life.

Last year, Zhaoli Dai-Keller at the University of New South Wales in Sydney, Australia, and her colleagues took a deep dive into the dietary habits of thousands of people aged 95 and over who still lived in community settings across east Asia, Australia and western Europe. By definition, these people had aged successfully, and the researchers found that they had earned it.

They were, on the whole, paragons of dietary virtue. Only a quarter drank alcohol, and they mostly ate a balanced and diverse diet rich in fruit, vegetables, white meat, fish and legumes. Something else also stood out, says Dai-Keller. "Salt intake tends to be lower in the centenarians," she says. High salt consumption is a causal factor in cardiovascular disease, the world's biggest killer.

In a similar study, Anne-Julie Tessier and Marta Guasch-Ferré at Harvard T.H. Chan School of Public Health in ›

"We gain a lot from increasing whole grains, nuts and legumes, and also reducing sugary foods and meats – processed and red meats in particular"

Boston, Massachusetts, and their colleagues reanalysed data from two research projects that followed more than 105,000 people over three decades starting in 1986, as they progressed from middle age into early old age. They were looking for evidence of healthy ageing, which they defined as reaching 70 free from major chronic diseases, as well as being physically fit and mentally sharp.

Only around 10 per cent of the participants achieved that, and when the researchers analysed what they had in common, they found that diet was key. The majority had stuck to healthy Mediterranean-style fare throughout middle age. Those who binged on fatty, salty and meaty foods, on the other hand, rarely aged healthily.

Reaching 70 in good health is no guarantee of getting to 100, of course, but it helps.

However, longevity isn't just about what you eat, but how much. According to the 2024 study led by Dai-Keller, one of the defining features of people aged 95 and over is that they are slim. Around half were a normal weight, and a third were underweight.

Obesity isn't a prescription for making it to 100, it seems. However, when the researchers looked at the ability of their participants to carry out basic daily living activities, they found that being overweight, but not obese, was significantly helpful for day-to-day functioning compared with being a normal weight. Being underweight increased the risk of impairment by around 25 per cent.

Which brings us neatly to one of the methods sometimes advocated for longevity: calorie restriction. One of the most reliable ways to extend the lifespans of laboratory animals is to restrict their preferred calorie intake by 25 per cent or more. However, it is hard for people to do this, and calorie restriction has yet to be proven to work in humans – and even if it does extend life, it might impair the ability to carry out day-to-day tasks.

All in all, though, if you want to give yourself the best chance of living to 100 in the best condition possible, a large slice of the secret is on your plate.

Graham Lawton

'I'm like an Olympian, but for longevity'

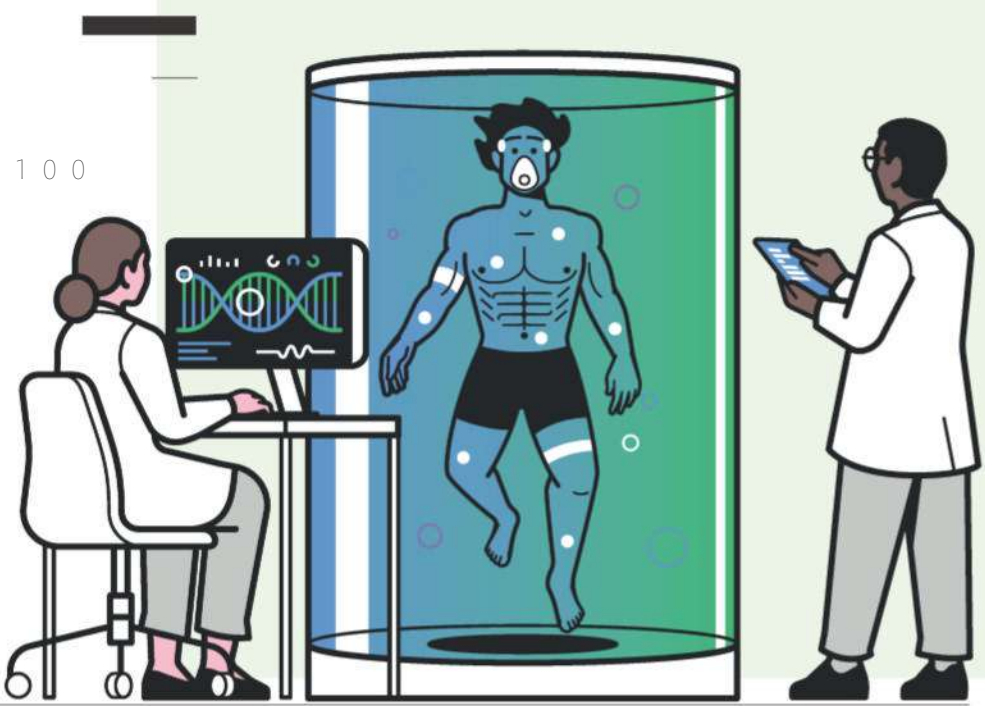
Tech millionaire turned longevity pioneer **Bryan Johnson** is going to extremes to reverse the age of his body. What can the rest of us learn from his radical approach?

BRYAN JOHNSON is finishing his 6.5-hour morning routine when I sign on to Zoom for my allotted 15-minute call (a constraint of what a member of his team describes as his "crazy" schedule).

The tech millionaire is standing in front of a cement wall in his California home, the coldness of which is relieved by green bursts of tropical houseplants. Wearing a helmet-like headset, wires trailing out and down past the screen, together with a black T-shirt bearing the words "Don't Die", the effect is somewhere between a luxury Balinese villa and a VR store designed by Apple.

Immortality has been a human preoccupation for millennia, but it is hard to imagine anyone going to greater lengths to reach for it than Johnson. Take his headset. That's an experiment to improve cognitive function by stimulating certain brain regions with infrared light. He has been using it for 10 minutes a day for the past two weeks "to see if the treatments have measurable effects on my cognition", he says.

The other 6 hours and 20 minutes that Johnson devotes daily to longevity work are spent, variously, measuring his waking body temperature, using serums for hair growth, working out for an hour – cardio, strength, balance – taking a 20-minute sauna, using red light therapy and hypoxia therapy (the latter is a new addition, involving breathing in varying concentrations of oxygen) before eating breakfast. This is a mix of ground nuts, seeds and blueberries, extra virgin olive oil,



pomegranate juice extract, cocoa, collagen protein, pea and hemp protein, cinnamon powder, Omega-3, Omega-6, grapeseed extract and macadamia nut milk, among other ingredients. All this is to "follow the data and the science" to turn back the clock.

"A lot of people hear this and they think, 'That's crazy'," he says. "The way they can think about it is I'm a professional rejuvenation athlete. I'm like an Olympian, but for longevity."

Johnson, now 48, began his longevity quest after a series of midlife endings: leaving the Mormon church he was raised in; ending his marriage; and selling his mobile payment company. That sale is how he made the millions that fund his endeavours.

In 2021, he announced the start of Project Blueprint, a mission to measure his organs and try to "maximally" reverse the biological age of each. (He also runs a start-up named Blueprint, selling supplements, blood tests and other products, which is the subject of multiple controversies.) Johnson claims that his bone mineral density is in the top 0.2 per cent of all people, his cardiovascular fitness is better than 85 per cent of 20-year-olds and he has the fertility health of a 20-year-old, too.

Going to extreme, and often unevidenced, lengths in the pursuit of a longer life isn't atypical for his tech millionaire cohort. But with a strict routine that entails having his last meal at 11am, Johnson is surely the most extreme player in the longevity game, and he has amassed a team of 30 specialists to assist with the quest. "We try to find people in every domain of expertise... the brain, the heart, protein patterns," he says. "This project really speaks to them because we're very playful, we're very experimental."

"Very experimental" is a fair assessment. Johnson's protocols sometimes involve taking drugs based on limited trials in humans, like rapamycin, originally formulated to act as an immunosuppressant for people after an organ transplant, and which is being investigated for possible anti-ageing effects. Promising results have been seen in mouse studies, but Johnson stopped taking the drug last year after experiencing side effects. His team then also found a study

Bryan Johnson devotes more than 6 hours a day to preventing ageing

indicating that rapamycin may accelerate ageing in humans.

So, is he ever fearful of experimenting with interventions that aren't backed up by solid science? "I would flip that. A lot of people would look at this experiment and say, 'Bryan, but wait, you are at so much risk!' and I say, 'Friend, you are at greater risk than I am because you are experimenting with fast food and staying up late and drinking alcohol and eating toxins'," says Johnson. "Their lives are higher-risk than mine. I am taking fewer risks overall because I eat well, I sleep well and I exercise all the time. I look at them and say, 'Why are you running the experiment to see what happens to you when you eat junk food?'"

If some scientists enjoy Johnson's experiment, others question the semantics used. Richard Siow, director of ageing research at King's College London, notes that certain biomarkers associated with ageing are reversible. Things like indicators of inflammation found in blood, lung capacity, lipid levels, cholesterol and epigenetics are all modifiable, he says. But that doesn't mean that attributing "ages" to them – for example, that someone has the metabolism of a 25-year-old at 40 – is possible. This is because we don't have population-wide datasets drilling into the average biomarkers of people at specific ages. Longevity clinics offering such tests are likely to be basing these on limited datasets, says Siow. "The numbers are good for marketing, but clinically less meaningful."

Unsurprisingly, Johnson's research team disagrees. "Bryan Johnson knows the biological age of his organs through extensive, scientific testing and monitoring... using a variety of methods including MRI scans, ultrasounds, blood work, genetic screening (such as epigenetic clocks), and other clinical tests," wrote one of them in an email. These metrics are shared via X, though they have yet to be analysed in peer-reviewed studies.

Still, Siow is glad that Johnson is willing to self-experiment in a way that couldn't happen in a clinical trial, due to ethical issues, even though it isn't possible to extrapolate from one person to the wider population, he says.

But for all his high-tech experimentation, Johnson's top recommendation for everyone aiming to live to 100 is pretty straightforward: "Lower your resting heart rate before bed," he says. "[This] determines how well you're going to sleep. And how well you sleep determines if you will exercise, and if you exercise, that determines if you will eat well. So [it starts] a positive cascade."

"Johnson's top tip for everyone aiming to live to 100 is pretty straightforward: lower your resting heart rate before bed"

To lower your resting heart rate, he recommends stopping eating 4 hours before bed; taking an hour to wind down before sleep by reading, having a walk or meditating, and avoiding screens; and being mindful of heart rate-raising stimulants like caffeine. "And the biggest one is rumination. Rumination can increase heart rate between five and 25 beats per minute [by thinking about] things you're mad about, worried about, obsessed about."

Johnson takes his own advice to the nth degree. Surprisingly, though, the number of years he has left on the clock is less of a preoccupation than his efforts suggest.

When I ask him how long he expects to live, based on his current biomarkers, he is solemn. "I don't think my life expectancy matters," he says, due to advances in artificial intelligence. Part of his "Don't Die" endeavour is to upload his thoughts to an AI model, meaning that he can exist in some form for an unquantifiable amount of time. "Right now is the first time we are seeing actual immortality being born, where you can in fact train a model on a human... The changes we're going to see with AI will be so dramatic and will happen much faster than my expected 40-to-50-year time span that I have left, that it's really not a relevant question."

Claudia Canavan

HOW TO NURTURE THE RIGHT MINDSET FOR LIVING TO 100

H O W T O L I V E T O 1 0 0

"I'M 87. I DON'T FEEL 87, I don't think like I'm 87," declared Elaine Neuwirth on TikTok. "The most important thing is to get involved... interact with other people... have a purpose. Get up and move... Be part of the world."

Her words, now viewed by 3.6 million people and counting, capture the growing scientific consensus that it isn't enough to just eat well and exercise regularly: to live a long life, you must nurture your psychological well-being, too. And while you can't outrun a lifetime of poor dietary choices and a sedentary lifestyle, there is evidence to suggest it is never too late to reap the benefits of making some psychological tweaks.

Let's start with your relationships. To understand their importance, turn to the longest in-depth study of human life ever performed, the Harvard Study of Adult Development. Since 1938, it has followed 724 boys and young men, and more than 1300 of their descendants, to identify what makes people flourish, both physically and mentally.

Mark Schultz, associate director of the study, says one thing stands out: high-quality relationships. It turns out that social ties are powerful predictors of late-life health and well-being. For instance, one analysis of data from the study showed that men who have more positive social relationships and are more involved with their community during midlife have a lower risk of depression and better cognition in late life.

"People we're close to help us figure out solutions to problems; they help us regulate difficult emotions," says Schultz. "Just being near people calms the body in important ways." This is because close relationships positively affect our hormones, our immune systems and even how our genes are expressed.

When people are in good relationships, their wounds literally heal quicker. Several studies published over the past year hint at why. They show, for instance, that having more close friends is associated with a stronger immune system in general and a greater proportion of cells that delay immune ageing – suggesting that sociability can help make the immune system more potent and youthful.

Having close friendships also appears to alter the activity of genes responsible for cellular ageing and several of the systems that help our bodies cope with stress. And since chronic stress is a known driver of heart disease, Alzheimer's and many other conditions, these effects can be significant over the long run. For instance, one analysis of 148 different studies of links between social connectivity and longevity found a 50 per cent increased likelihood of survival for participants with stronger social relationships.

But how many relationships are enough? "If you have no one who's got your back, then going from zero to one will obviously bring huge gains," says Schultz, "but the literature is pretty consistent that larger networks are associated with better health."

A useful test, he says, is to ask yourself who you would call if you woke up sick or scared at night. If no one comes to mind, you may be at risk of loneliness, a driver for depression, heart disease and cognitive decline. Loneliness is so bad for our health that its influence on early death is greater than that of obesity.

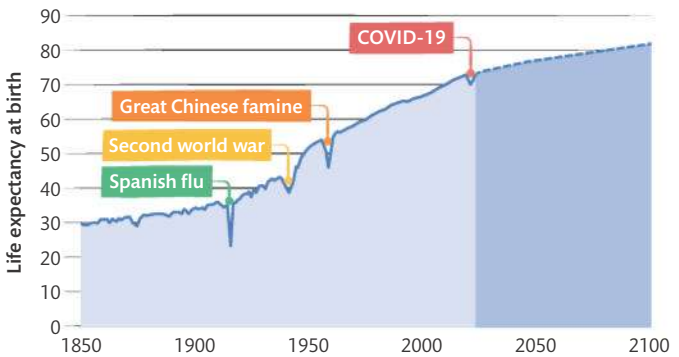
"The emotional pain resulting from loneliness can produce the same stress response as a chronic medical condition and thus lead to chronic inflammation and reduced immunity," says Ashwini Nadkarni at Harvard Medical School. "This is why enhancing a sense of community can be so important while ageing."

The good news is that tackling loneliness doesn't require professional help. Clinical psychologist Katherine Schafer at Vanderbilt University Medical Center in Tennessee recommends two steps: find a way to contribute to someone else's life and let others contribute to yours. "Start super small. Did you see a new parent drop a toddler's shoe? Grab the shoe and hand it to the parent. You have positively impacted someone," she says. "Letting people do the same for you, and considering the way they cared, can have a great impact and lead to connections – the antidote to loneliness."

Alongside tending to your social connections, you might also want to consider your sense of purpose. Yes, it may whiff of unscientific woo, but there's growing consensus that purpose – something that gives

Global longevity leap

Average life expectancy is now 42 years longer than it was in 1850, and is still rising. This means the number of centenarians is rising, too.



SOURCE: GAPMINDER, UN POPULATION PROJECTIONS

your life direction or makes it feel meaningful – can keep you alive for longer.

Having purpose is associated with a reduced risk of chronic disease and overall mortality. The mechanisms haven't been elucidated just yet, but having purpose is thought to lower stress levels and motivate people to exhibit healthier behaviours. If it doesn't come naturally, though, can finding purpose later in life make a difference?

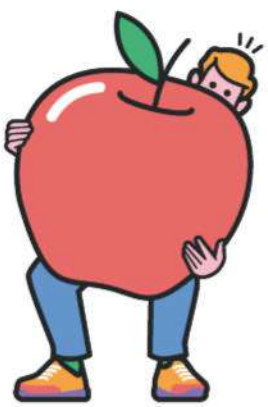
In 2022, Eric Kim at the University of British Columbia in Canada and his colleagues set out to answer that by analysing data from nearly 13,000 US adults over 50. Participants had their sense of purpose and health measured across eight years. Those who found more purpose in life over that time had higher physical activity, fewer sleep problems and reduced risk of stroke and overall mortality.

It can also help to try to fight back against any negative attitudes you have about ageing itself. A 2022 study of almost 14,000 US adults over the age of 50 found that those who felt most positive about ageing had a 43 per cent lower risk of dying of any cause over four years compared with those who felt the least positive.

Other studies have shown the influence of mindset on health: shifting away from negative thoughts can reduce chronic stress, while becoming optimistic can decrease your risk of heart disease.

Stacking the odds in favour of a long and healthy life was always going to require effort. So, alongside diet and exercise, remember to nurture your psychological well-being. Call a friend, embrace ageing and reflect on what is truly valuable. As Neuwirth says, get up and be part of the world. It might just help you stay in it for longer.

Helen Thomson



WHY TAKING CARE OF YOUR MICROBIOME IS KEY TO A HEALTHY OLD AGE

IF YOU WANT to live to a grand old age, it might help to think of yourself not as a human, but rather a holobiont – a collective of human cells plus the trillions of microbes that live in and on you.

Because it isn't just our own cells that change with age; our microbiome transforms too. And, increasingly, researchers are showing that our friendly – and not so friendly – bacteria and other residents lie at the core of healthy ageing. Nurturing them may be a smart way to live healthier and longer.

More than a century ago, zoologist Élie Metchnikoff speculated that senility was caused by "putrefactive bacterial autotoxins" and recommended fermented milk and a simple lifestyle as a remedy. Today, that early theory has blossomed. We now know that our microbiome is so deeply embedded in our physiology that it influences everything from digestion to metabolism and even brain function.

Yet untangling its impact has been challenging. "The complexity of the microbiome is akin to the complexity of the human brain," says microbiologist Filipe Cabreiro at Imperial College London.

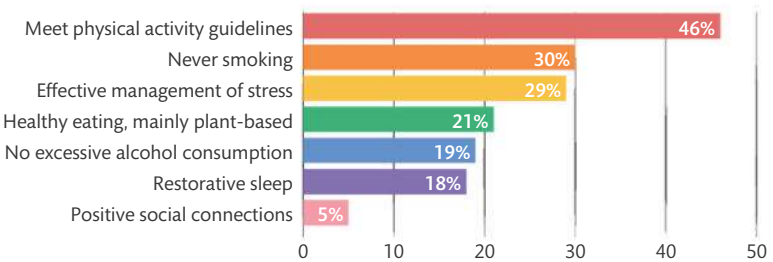
No two people's microbiomes are the same, and even within an individual, it can shift from day to day. But we are gaining some vital clues. We are getting a much better idea, for instance, about which gut residents are beneficial and which are pathogenic. One thing has become clear: diversity is key. The greater the variety of gut microbes, the healthier you tend to be.

Unfortunately, as we age, our microbiome changes, tending to show a decreased abundance of healthy bacteria in later life. Older adults tend to eat less diverse diets, take more medication and have fewer social interactions – all of which have knock-on effects on the types of microbes living in the gut. But even animals raised in identical conditions throughout life show age-related changes in their microbiome, suggesting an intrinsic shift with age.

To understand the impact of this decline, many researchers have focused on microbes that produce short-chain fatty acids (SCFA) through the fermentation of dietary fibres. SCFAs are involved in many beneficial processes, such as maintaining the cells in our gut lining, suppressing ›

Lifestyle habits to boost longevity

Adopting certain healthy habits can extend your life by decades, according to a large US study. A 40-year-old who adheres to these habits can expect to live more than 20 years longer than a person who adheres to none of them



SOURCE: AMERICAN JOURNAL OF CLINICAL NUTRITION

inflammation, regulating our immune system's response to pathogens and controlling blood sugar levels.

As we age, the number of microbes making SCFAs reduces while the pro-inflammatory ones increase. "This imbalance is thought to contribute to chronic, low-grade inflammation, a state known as inflammaging, which is associated with higher risk of conditions such as cardiovascular disease, dementia and stroke," says Jessica Schneider, chief scientific officer at Corundum Systems Biology, a company in Tokyo, Japan, that invests in research.

However, the gut microbiomes of people who reach extreme old age seem to be better able to resist this decline. Key evidence of this comes from a 2023 study of 1575 people aged between 20 and 117 by Shifu Pang and Xiaodong Chen of Guangxi Medical University in Nanning, China, and their colleagues. The study found that, compared with adults aged 66 to 85, the gut microbial signature of those aged 100 to 117 was more similar to that of young people, with higher diversity and greater abundance of beneficial bacteria from the Bacteroides phylum. "Our results strongly suggest that the gut microbiota signatures of centenarians show similarity to those of young people," the researchers concluded, and speculate that this factor contributes to longevity.

> "The gut microbiota signatures of centenarians show similarity to those of young people"

This raises the question of whether we can nurture our microbiome to age better.

Changing your gut microbes isn't easy. "You're trying to introduce a complex community into another complex community that tends to be strong," says Cabreiro. Nevertheless, while prebiotics, supplements which provide food for helpful gut microbes, and probiotics, gut-friendly microbes that you can take as a supplement, may not fundamentally reshape the microbiome, they might give it a nudge in the right direction, at least temporarily.

For instance, last year, nutrition company Zoe showed in a randomised trial that its prebiotic, with 30 plant-based nutrients, increased beneficial bacteria, with some improvements in health measures such as inflammatory compounds in blood.

Another study, of 50 adults living in nursing homes, showed that taking a daily prebiotic containing the plant-

derived compounds fructooligosaccharides and inulin over 13 weeks improved measures of frailty compared with a placebo.

Dietary changes may be just as effective. When older adults across several countries adopted a Mediterranean diet for one year, those who adhered most closely retained more microbial diversity and boosted gut microbes linked with healthy ageing. This correlated with many improvements to their health, says Schneider, such as better walking speed, strength and memory.

More radical treatments are also being explored. Faecal microbiota transplants have already been approved for *Clostridium difficile* infections, and promising data shows they could also treat other conditions, but whether such approaches can extend lifespan remains an open question. In animals, swapping out an old microbiome for a younger, healthier one has striking results – older killifish live 37 per cent longer if they have eaten the faeces from younger fish, for instance. Mouse experiments show similar gains.

But the field is still in its infancy, says Cabreiro. We have much to learn. Microbial activity affects many biological pathways associated with ageing, including those in mitochondria, metabolism and the immune system, and we are only just beginning to explore how we might manipulate our microbes, through diet, drugs or even CRISPR gene-editing technologies.

"It's early days, we haven't figured it all out properly," says Cabreiro, "But there's excitement about how this can all benefit our health and longevity – and rightly so."

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THE SECRET SAUCE TO GETTING TO 100

MY PARENTS are both in their 80s and are fit and well for people of their age. I would like them to be around for many years longer. But how do you get from your 80s to 100 and beyond?

Good fortune plays a big part: avoiding fatal accidents or deadly infectious diseases and living in a peaceful country with clean water and a good healthcare system. It also helps if you win the genetic lottery. Women are much more likely than men to notch up a century: more than three-quarters of centenarians are female, and the list of the oldest-ever humans is utterly dominated by women.

Longevity also runs in families, and geneticists have identified hundreds of gene variants associated with living to a ripe old age. Research on twins and family trees suggests that the biological traits associated with extreme longevity are about 30 per cent heritable. Most of these genes appear to confer unusual levels of protection against the diseases of old age, such as cardiovascular disease, according to Nir Barzilai, who studies "superagers" at the Albert Einstein College of Medicine in New York City.

The best way to tell if you have got a longevity-promoting genome is to look at your parents, if this is possible. There isn't a whole lot you can do about your DNA, but the good news is that there is still plenty of scope to actively intervene. That might suggest a life of virtuous restraint – good diet, lots of exercise and sobriety. Surprisingly, however, these don't appear to make much difference, at least in people who have already attained exceptional longevity.

A 2011 study dug into the lifestyles of 477 Ashkenazi Jews who had made it to 95 and were still living independently. Three-quarters of them were women; the oldest was 109. The researchers collected data on their diet, physical activity, smoking, alcohol consumption and body mass index, and compared this to a representative sample of the general population born at the same time, most of whom had already died. There were no significant differences. The survivors were just as likely as their deceased peers to have drunk alcohol regularly, had similar BMIs and done similar amounts of exercise.

But don't read too much into that, warns Barzilai. Among these very old people will be a disproportionately large number of the lucky few who inherited a great set of longevity genes and can withstand all sorts of insults that would do the rest of us in.

For mere mortals, a healthy lifestyle is absolutely crucial to keeping going after 80. "There are four things," says Barzilai. "Optimise your exercise, your sleep, your diet and your social connectivity." Strength and flexibility exercises become increasingly important in older age, and 8 hours sleep is a good target. Eating a Mediterranean-style diet plus ›

"Women are much more likely than men to notch up a century: more than three-quarters of centenarians are female, and the list of the oldest-ever humans is utterly dominated by women"

New Scientist Live

Can we eat our way to happiness?
Hear Emily Prpa reveal more about the gut-brain connection on 18 October **newscientist.com/nslmag**

Longevity hacks

Here are five simple but lesser-known things you can do now for a healthier older age.

Sit on the floor

Sitting on the ground isn't just for children. Getting up and down from the floor strengthens leg and core muscles and keeps joints flexible. What's more, the ability to do this as an adult is linked to a significantly longer life. If possible, try getting up without using your hands for an extra challenge.

Floss your teeth

Let your oral hygiene slip, and harmful microbes from your mouth can travel all over the body, triggering problems – from cardiovascular disease and cancer to Alzheimer's disease and arthritis. Keeping your oral microbiome in balance, however, staves off decline.

Train your nose

A declining ability to detect aromas is linked to conditions such as Parkinson's and Alzheimer's. Restoring this neglected sense might not only reduce cognitive decline, but studies also show it could reverse it – and the ability to smell is something that can be trained.

Have sex

"A fulfilling sex life is an essential part of subjective well-being" was the conclusion of one review of research into the link between the sex lives of people aged 40 to 90-plus and how positively they felt about themselves.

Mix with younger people

Aside from any psychological benefits, your microbiome will get a boost from mixing with younger people. Our gut microbiomes are shaped by those of the people around us, and a shift to a more youthful profile is linked to better health.

intermittent fasting, such as the 16:8 diet, is also very effective, he says.

How we look after our cognition also matters. This is the finding of a 2024 study of the life-course pathways that lead to exceptional longevity, which followed 547 people from the Lothian Birth Cohort study for 24 years after they reached the age of 79. The research revealed that cognitive ability in later life was an important predictor of survival in the oldest participants, having more impact on longevity than their physical functioning.

This highlights the importance of making our brain "fitter" throughout our lives by building new brain connections or "cognitive reserve". However, the Lothian study found that three early life factors – childhood social class, IQ at age 11 and length of time spent in education – were key contributors to higher cognitive function aged 79.

Social connectivity is perhaps the surprise ingredient. A few years ago, Boo Johansson and Valgeir Thorvaldsson at the University of Gothenburg in Sweden dug into data collected on 699 octogenarian, nonagenarian and centenarian Swedes who had subsequently died to see what distinguished those who made it only to their early 80s from those who kept going through into their late 80s and beyond. Predictably, they found that a healthy lifestyle increases the likelihood of living longer. But social factors also scored very highly. "Perhaps the most striking finding, at least for the general public, was the relative importance of what might be called 'softer' factors," says Thorvaldsson. "Higher life satisfaction and stronger social connections."

People over 80 who had people to talk to and felt part of a friendship group survived longer than those who lacked company or felt abandoned. The closer and more emotionally rewarding those connections, the better.

Life satisfaction also had a major impact. This was measured by the responses to 13 statements such as "As I grow older, things seem better than I thought they would be" and "When I think back over my life, I didn't get most of the important things I wanted."

Other researchers have also found that low life satisfaction is a major risk factor for earlier death among men in their 80s. "We were not surprised to find an association between life satisfaction and mortality, but we were quite surprised by the magnitude of the effect," says lead researcher Phil St John at the University of Manitoba in Winnipeg, Canada.

Good social connectedness and life satisfaction aren't always easy to engineer, but there is another route to healthier ageing, says Barzilai. "There are four drugs that can be repurposed to treat ageing," he says. These are the diabetes drugs metformin and the SGLT2 inhibitors, GLP-1 agonists like the weight-loss or diabetes drugs Ozempic and Wegovy, and the osteoporosis drug zoledronic acid.

These medicines were developed for specific conditions, but they also happen to target the biology of ageing in general. "All the evidence is that you take them at an old age and prevent a variety of diseases and also overall mortality," says Barzilai – though whether your doctor will prescribe them to "treat" ageing is a different matter. ▮

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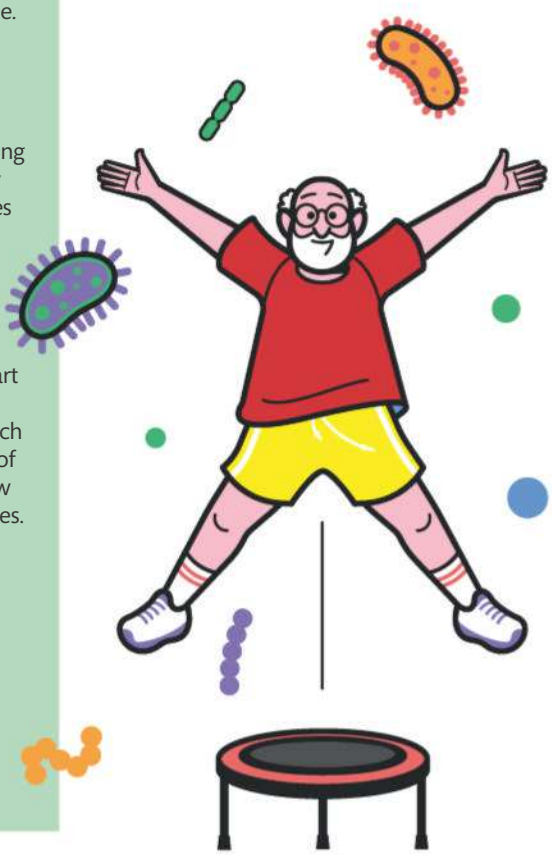

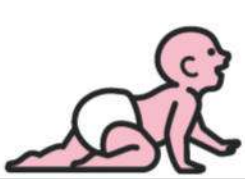

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NOVA

What it's like to run the world's best dark matter detector

Physicist **Chamkaur Ghag** is on a mission to find the 85 per cent of the universe's matter we haven't yet identified. He tells Leah Crane how the hunt is going and what it would mean if we found it

DEEP underground in the middle of South Dakota, the most sensitive dark matter detector on Earth sits quietly waiting. This is the LUX-ZEPLIN (LZ) experiment, the central part of which is a large tank of liquid xenon. Physicist Chamkaur Ghag at University College London is one of the leaders of the huge scientific collaboration working on the experiment. Its mission is to find the 85 per cent of the universe's matter that we haven't yet identified.

Today, Ghag and his fellow hunters stand at something of a turning point in the search for this elusive substance. There are loose plans to build a detector called XLZD, which would be several times the size of LZ and even more sensitive. But if both of these fail to sniff out the goods, it will force physicists to reconsider what they think dark matter is made from.

As Ghag says, that may mean the next generation of dark matter detectors won't be underground behemoths, but surprisingly small and humble affairs. In fact, he explains in advance of his upcoming talk at New Scientist Live this October, he has already built one such prototype.

Leah Crane: First things first, why is dark matter so important?

Chamkaur Ghag: On the one hand, we have particles and atoms and everything that particle physics tells us about how the constituents of matter come together. On the other hand, we have our understanding of gravity. It may seem like this is all good, but if you try to put gravity and particle physics together, there's a big problem: our galaxy shouldn't be here. It's holding itself together with gravity that seems to come from matter that we can't see. And it's not just a little glue. Some 85 per cent of the matter in the universe is this so-called dark matter.

Why have we been hunting for it for so long and not found anything?

At the moment, we think dark matter is probably made of what we call WIMPs, or weakly interacting massive particles, which were born in the early universe. If so, it would only very rarely interact with other particles and even then give off an extremely feeble signature. So, we need huge detectors. The larger they are, the better the chance that a dark matter particle going through it will interact. And they have to be really quiet so they can be sensitive to the tiny recoils of particles hit by dark matter if it interacts – even the slightest vibration could mask the signal.

We talk about a theoretical phase space for dark matter, which means the range of possible masses and properties that this stuff could have. We have already ruled out some of this space. So we have to keep getting deeper underground, with larger and larger detectors, to approach the promised land: the theoretical phase space where particles of dark matter could still exist.

It is a ridiculously painstaking craft. With our detector, we had to make sure there was almost no background noise. For instance, most metals produce tiny amounts of radioactivity, so we had to work hard to minimise that problem in our construction materials. LZ is the lowest background noise, most radio-pure instrument on the planet.

So LZ is the most sensitive detector that we have right now – how does it work?
Essentially, it's a double-walled Thermos flask a few metres wide and a few metres tall that contains 7 tonnes of liquid xenon. In this flask, the xenon is in a highly reflective barrel, and it's viewed from the top and bottom by light sensors. And then there's a final touch: we have an electric field across this barrel. If a WIMP comes in and hits a xenon nucleus, it would produce a small flash of light, a few photons. But because we've got an electric field, we pull away the electrons [freed up in the collision] from the nucleus, and also produce a separate, brighter flash.

This means that anything that happens in our detector gives us two light signals. Where that happens tells us the position of the event, and then the amount of light from the primary flash versus the secondary flash tells us the microphysics of whether this was a WIMP that came in and hit the nucleus or something else, like say a gamma ray. We have it all a mile underground to shield from cosmic rays, and then we have it in a water tank to shield it from the rock itself.

It is such a complicated endeavour. What was the hardest part in getting it to work?
There was a similar, smaller predecessor experiment called LUX and we knew what we needed to do to get the instrument 10 times more sensitive. Actually doing it was challenging, if satisfying. For me, the hardest part was making sure the instrument was as clean and quiet as it needed to be. If you take LZ and you unfurl it, it's huge, it's a football pitch-sized area and we can only tolerate a single gram of dust on that whole surface.

What's it like to work at that ultra-clean detector so far underground?
It's a former gold mine, so there's this very industrial-looking environment. You get your hard hats on and you go down a mile, and then there's a bit of a trek to the lab. Once you're into the lab, you can forget where you are. Then you're into clean-room garb and it's computers and equipment and whatnot – it's just a lab with no windows. But the journey down is sort of otherworldly.

Up to now, WIMPs have been the dominant candidate for dark matter. But with nobody spotting any evidence of them yet, at what point do we say WIMPs are dead?
I think if we reach the point where XLZD, the larger detector we have planned, has been built and has not seen them. If we are having to explore beyond the range of that instrument, it gets hard for the cookie-cutter standard WIMP to exist. But until that point, they're still crazy alive. That territory between what we have explored so far and where XLZD will get, that's the fun stuff.

You have developed a completely different and far smaller detector for dark matter. Tell us about that.
What we have is a 150-nanometre-wide glass bead that we levitate with lasers so that it acts as a highly sensitive force detector. What's nice is that we can tell if it moves in any of the three dimensions. So, we can say, 'OK, something has pinged it from a particular direction'. That's great, because it means that now you can start to rule out all your terrestrial backgrounds, like radioactive decay from materials underground.

That's quite a departure from the huge detectors like LZ. What's the rationale behind building that – and will we see more small detectors?
The large underground experiments are huge, so they are super sensitive – but in a sense, the fact that they are so large actually limits their sensitivity. Let's say that whenever a dark matter particle hits my xenon detector, it produces 10 photons. I can easily detect all of those if my xenon tank is small, but if I have a huge tank, they have to bounce around all over the place and I might only catch three of them.

Now, let's imagine that any time a dark matter particle hits my detector, it only ever produces two photons in the first place. In that scenario, the maximal signal you can get from a detector akin to LZ diminishes. That's why there is now a push to look for lower mass dark matter particles that are outside of the range of LZ – and that means turning to other sorts of detectors.

Let's say we actually find dark matter. What does that mean for physics and the universe?
It solves two problems. This is the obvious one: what is this missing 85 per cent of the matter in our universe? But it would do that in a way that doesn't involve the standard model of particle physics, our essential list of the building blocks of reality.

So, if you find dark matter, you have your first peek outside this model. We have no solid evidence for anything specific outside of the standard model yet – nothing at all. This would be that first beam of light into the room. ▮

SANFORD UNDERGROUND RESEARCH FACILITY/MATTHEW KAPUST

The LUX-ZEPLIN dark matter detector was built in an old gold mine

Leah Crane is a features editor at *New Scientist*

NewScientistLive

Hear more from Chamkaur Ghag at this year's New Scientist Live. On Saturday 18 October, he will delve into the fascinating world of dark matter detection and describe the search for this elusive stuff in the Milky Way.

For more information, visit newscientist.com/nslmag

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The science of exercise

Refuelling after a workout

Taking care of your body's nutritional needs after training is simpler than you might think. **Grace Wade** sums up the research

Grace Wade is a health reporter for *New Scientist* based in the US

WHEN it comes to exercise, I'm not someone who cares about maximising my performance or hacking my biology – I just want to move and challenge my body. So you can imagine how little thought I put into post-workout meals. But training for a half-marathon has taught me how important it is to refuel my body – and why it doesn't have to be complicated.

To be clear, when it comes to post-workout nutrition, needs will differ depending on the type of exercise you do, how long you do it for and factors like age, sex and genetics. That said, an April review in *Sports Medicine* found strong evidence for three interventions when it comes to muscle recovery and better performance. I see them as the pillars of a post-workout meal.

The first is carbohydrates. During exercise, the body dips into its energy reserves in the liver and muscles. Refilling them is crucial to prevent further muscle breakdown and to ensure you have enough fuel for your next workout. Carbs are the most effective option, as your body quickly converts them into energy.

The review recommends that in the 4 hours after intense exercise, athletes should consume between 1 and 1.2 grams of carbs per kilogram of body weight every hour. That is roughly what most adults eat in a day, so this advice is perhaps best reserved for athletes. Even so, grabbing a carb-rich snack or meal after exercise is probably a good idea. Choose something that contains both glucose and fructose: the glucose restores energy in muscles and fructose replenishes reserves in the liver. Fruit ticks both boxes, so it's ideal.

CREAM_PH/GETTY IMAGES

The second pillar is protein, essential for muscle recovery. Pairing it with carbs also seems to boost performance. A 2016 study of eight athletes found those who ate both within 2 hours of tough cycling could ride for an average of 14 minutes longer in their next workout compared with those who only ate carbs. The amount of protein also matters more than when you eat it. The *Sports Medicine* review suggests 20 to 40 grams of protein after working out – about as much as in a serving of chicken or protein powder.

Last, but not least, are fluids. You can stick with water, but other beverages may be more effective. For instance, a study of 72 men (also in 2016) found that oral rehydration solutions, milk and orange juice were all better for hydration than water because they contain electrolytes that help your body absorb and retain fluids. Tea, coffee, sodas and even lager were as effective as water. I'm not saying have a pint after exercising, but if water doesn't appeal, a drink you enjoy should do the trick.

I'm still opting for simplicity, but now I aim for these three pillars. My go-to is a smoothie with frozen fruit, orange juice and protein powder. It isn't perfectly optimised, but it is a step up. And after a run, it always hits the spot. ▮

The science of exercise appears every four weeks

Next week
Dear David

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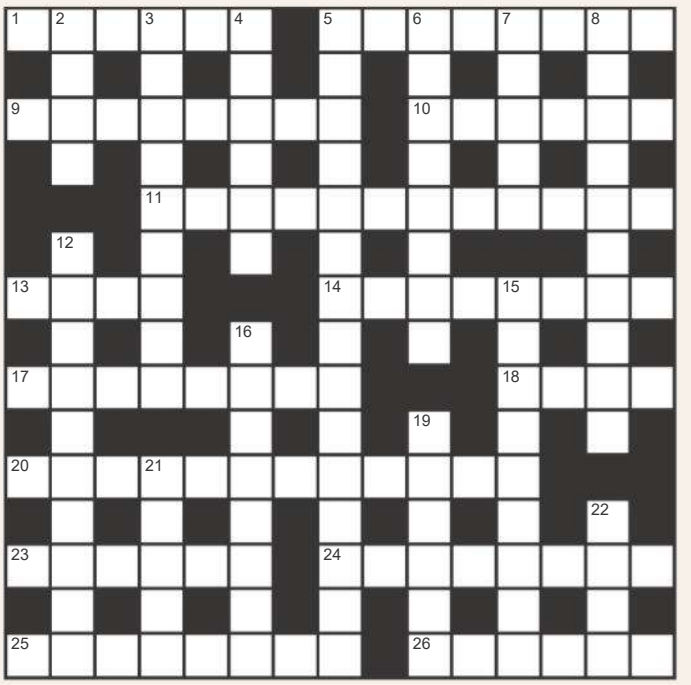
Quick crossword #192 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Flowering plant such as *Vanilla planifolia* (6)
5 Taxonomise (8)
9 Lead poisoning (8)
10 Of an angle, more than 90 degrees (6)
11 Chemical compound, $Te(OH)_6$ (8,4)
13 Primo ___, Italian chemist and author (4)
14 Involuntary urination (8)
17 1983 techno-thriller starring Matthew Broderick (3,5)
18 S-shaped architectural element (4)
20 The study of chemical processes within organisms (12)
23 Atoll used for nuclear tests from 1946 to 1958 (6)
24 Seventh Mersenne prime exponent (8)
25 Spine (8)
26 Straightforward; elementary (6)

DOWN

2 Rotation of an aircraft along a nose-to-tail axis (4)
3 One of three posterior leg muscles (9)
4 Boring tools (6)
5 Information technology (8,7)
6 Plant genus that includes wolfsbane (8)
7 Designation of the research facility where Chicago Pile-2 was constructed (4,1)
8 Preserved in stone (10)
12 Infectious liver disease (9,1)
15 Network of living things (9)
16 Bacterial skin disease (8)
19 Units equivalent to 6.3 kilograms (6)
21 Francis ___, DNA pioneer (5)
22 Small freshwater duck (4)

Our games are now solvable online
newscientist.com/games

Quick quiz #320
set by Corryn Wetzel

1 Which element has the highest electronegativity?

2 What is the term for the inability to recognise faces?

3 What is the name of the second-brightest star in the night sky?

4 How many chambers does a crocodile heart have?

5 Which law predicts that computer processing power doubles every two years?

Answers on page 55

BrainTwister
set by Christopher Dearlove
#91 Balls in boxes

We have four boxes numbered 1 to 4 and four balls numbered 1 to 4. How many ways can we put the balls inside the boxes so that there is one ball per box?

In some of those cases, a ball is in the box with the same number. How many ways are there to put the balls in the boxes so that no balls are in a box with the same number?

Imagine we start with box 1 and put a ball in it other than ball 1. Then we go to the box with the number of the ball we just added and put any ball in it other than ball 1. We continue like this until the last box, where we put in ball 1. How many ways are there to do this?

With four boxes, the three answers to the previous questions are numbers in strictly descending order. Does this continue to be the case when you have more than four boxes?

Answers next week

Weight of the world

Does Earth's mass remain constant, or is it slowly gaining or losing any?

Mike Follows
Sutton Coldfield, West Midlands, UK
Between 50,000 and 100,000 tonnes of light gases such as hydrogen and helium escape from Earth's upper atmosphere each year. This is partly offset by the annual gain of approximately 40,000 to 50,000 tonnes – mostly in the form of meteorites and cosmic dust. The result is a net decline of up to 60,000 tonnes annually, which seems like a lot.

However, over the time since Earth was created about 4.54 billion years ago, this adds up to a total loss of only about 45 parts per billion of its mass. If stated in terms of Earth's human population of roughly 8 billion, this is equivalent to about 360 people – just enough to fill two Boeing 737-800 aircraft, or roughly equal to the increase in the global population that takes place in just under 3 minutes.

Of course, this is the situation after Earth was struck by Theia, a Mars-sized object, shortly after it was formed. The collision led

"Earth's mass goes down by about 65 tonnes a year as a result of sending out spacecraft that never return"

to the creation of the moon and, though computer simulations of the event differ, probably resulted in a roughly 10 per cent increase in the mass of Earth.

Alex McDowell
London, UK
Overall, Earth is losing mass at around 50,000 tonnes a year – about 8.4×10^{-18} per cent of its total.

Around 100,000 tonnes of our atmosphere escape into space – mainly hydrogen and helium.

A gas at a given temperature contains molecules that travel at a wide range of speeds. Some of the fastest exceed the velocity needed to escape Earth's gravity, which is 11 kilometres per second. Lighter gases travel faster and thus have a higher percentage of molecules with speeds greater than this velocity.

In the upper atmosphere, ultraviolet light can break up water molecules, producing hydrogen, some of which escapes from our atmosphere. Helium is constantly produced inside Earth through radioactive decay and can also escape into space.

We only lose about 65 tonnes of mass a year as a result of sending spacecraft on escape trajectories. Orbiting satellites will eventually fall back to Earth. Earth gains about 40,000 tonnes a year by accreting meteoric dust and debris from space.

JAMES ROWLAND/500PX/GETTY IMAGES

Can walking into a fresh spider's web spell the end for the arachnid that built it?

This week's new questions

Sticky end **If I (accidentally) walk through a fresh spider's web, is this a major blow to the survival chances of its occupant?** ***Steve Archbold****, Chichester, West Sussex, UK*

Snot a problem **Are there any advantages to consuming and digesting our nasal mucus?** ***Celine Schwartz****, Thornbury, Ontario, Canada*

Go for a spin

If Earth turns at (say) 1000 kilometres per hour at London's latitude, when wanting to travel, why not just go straight up and wait for your destination to rotate around until it is beneath you? (continued)

Eric Kvaalen
Les Essarts-le-Roi, France
All the answers published previously say this wouldn't work, although Ron Dippold did say that you could end up 1.3 metres west of where you started. But the idea would work. If you have a rocket and launch yourself straight up with a speed of several kilometres per second, you will go into a highly eccentric, elliptical orbit.

You will go thousands of kilometres away from Earth, and then start coming back down. Though the horizontal component of your velocity starts at 1000 kilometres per hour, it goes down in proportion to how far you are from the centre of the planet. Where you come down, the solar time will be a bit later than it was when and where you blasted off, but Earth will have turned while you were in space, and you will come down at a longitude further to the west. As the eccentricity approaches its maximum value (which means you may go as far away as the moon, or further), the duration of your trip gets longer and longer, so it may be days before you come back down, and you will have effectively gone around the world several times.

This means blasting off with a speed of around 11 kilometres per second and coming back down with the same speed. If you start in the northern hemisphere, you will end up at a latitude a little bit south of where you started.

Of course, it isn't the most energy efficient way to get to New York. And you wouldn't survive the vertical re-entry into the atmosphere or the crash landing.

Better to go by blimp.

Martinus Roos
Elgin, Moray, UK
We have been tragically told on these pages that you can't just hop into the air and expect Earth to spin underneath you to get to your destination – apparently, the atmosphere rudely insists on sticking with the planet. Well, not always.

The Scottish islands of Orkney, the land where the wind never takes a coffee break, offers a slightly breezier alternative: just hop in a balloon and let the wind do the driving. Stay aloft at the right latitude, and you

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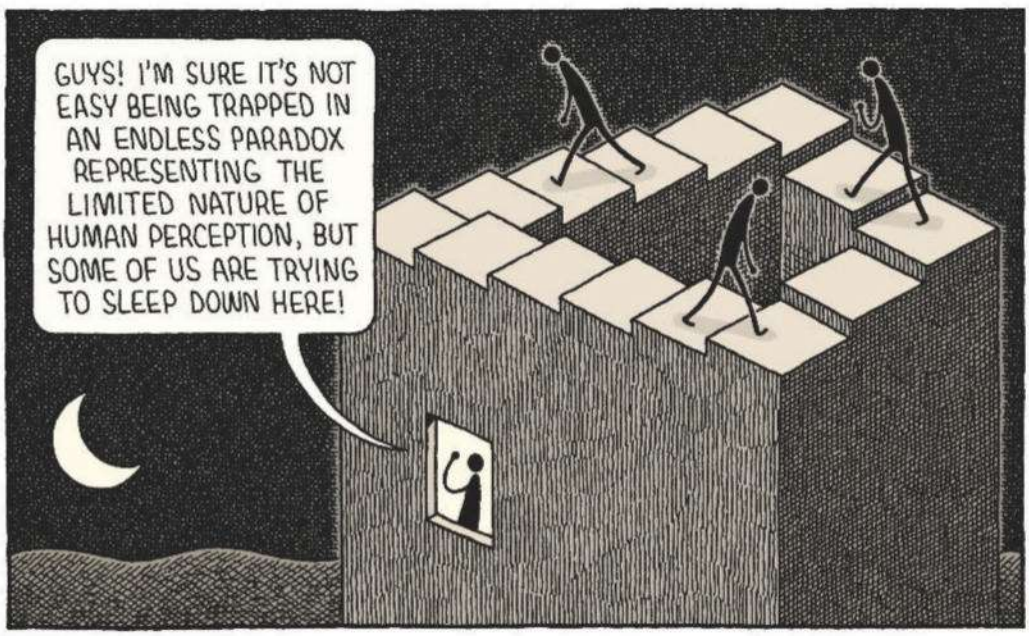
GUYS! I'M SURE IT'S NOT EASY BEING TRAPPED IN AN ENDLESS PARADOX REPRESENTING THE LIMITED NATURE OF HUMAN PERCEPTION, BUT SOME OF US ARE TRYING TO SLEEP DOWN HERE!

will circumnavigate the globe in a year – no passport required (though maybe pack snacks).

I should know – my anemometer clocked an impressive 19,000 miles of wind over nine months before it was violently retired by one particularly determined gust. Earth's circumference at that latitude is 20,000 miles.

So don't delay – come to Orkney, launch a balloon and drift your way into an international adventure. Or at least to Shetland.

Gas or grass?

I use a petrol lawn mower – does it emit more carbon than the grass captures? (continued)

Ned Gayner
Charing, Kent, UK
We have half an acre of wild-flower meadow on the shoulder of the North Downs that I mow once a year in the early spring.

When we first moved here, I used a heavy duty brush-cutter to mow the meadow, but that had

"I was unhappy to be killing reptiles when mowing my wild-flower meadow, so I bought a scythe. No more dead snakes"

a couple of problems: I started to develop early symptoms of the condition known as vibration white finger and I was also a bit unhappy to be killing reptiles.

So I bought a scythe, reasoning that a design that had been continuously refined for more than 5000 years had to be intrinsically easy to use. What I didn't anticipate was that a job that used to take upwards of two weeks could be easily completed in two days. And the bonus? No more dead snakes and lizards. It seems they know about scythes, but not about machine tools.

So: gas or grass? Neither!

Chris Daniel
Glan Conwy, Colwyn Bay, UK
A lawn, like any other biological system, is part of Earth's carbon cycle. In the carbon capture or sequestration phase of the cycle, the grass absorbs carbon dioxide from the atmosphere during photosynthesis along with water and sunlight and converts it to energy for growth. Carbon is also absorbed into the soil.

In the carbon release phase of the cycle, some of the carbohydrates in the cut grass are returned to the atmosphere immediately in a process called respiration.

If the grass clippings are left on the lawn, the organic matter is broken down by soil microbes, releasing nutrients for the grass below, and enabling further carbon sequestration and growth. This cycle continues indefinitely.

However, fossil fuels such as oil, gas or coal come from a different carbon "account", having been underground for hundreds of millions of years. A petrol mower emits CO_2 that hasn't been part of the current carbon cycle, so no matter how efficient its motor is, it can't offset its emissions against the carbon capture of the lawn. ▮

Answers

Quick quiz #320 *Answers*

1 Fluorine
2 Prosopagnosia
3 Canopus
4 Four
5 Moore's law

Cryptic crossword #170 *Answers*

ACROSS 7 Bireme, **8** Theory, **9** Eddy, **10** Antigens, **11** Billion, **13** Krill, **15** Ovine, **16** Heronry, **18** Anthills, **19** Nemo, **21** Powder, **22** Wrench

DOWN 1 Gild, **2** Jekyll and Hyde, **3** Megaton, **4** Stats, **5** Geiger counter, **6** Granular, **12** Inventor, **14** Seesaws, **17** Glare, **20** Mica

#90 Discount disco *Solution*

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Raining cats and dogs

Kristian Steensen Nielsen seems like a sensible type. A researcher at the Copenhagen Business School in Denmark, he studies "the role of behavior change in mitigating climate change and conserving biodiversity". In other words, how can we make our lives more environmentally friendly, and how and when do those changes scale up to become truly effective?

So Feedback was taken aback to see a recent LinkedIn post by Nielsen, which began: "Apparently, we've written a paper about how dog ownership causes extreme weather". He was citing a story on the website of KXAN, a TV station in Austin, Texas, headlined: "Dog ownership's role in extreme weather is vastly underestimated, new study finds".

Naturally, our mind went first to the butterfly effect and the power of chaos theory. If a butterfly can flap its wings in South America and cause a rainstorm in London, then surely a dog wagging its tail in Texas can cause an apocalyptic hurricane on the other side of the world?

However, it turns out we're talking about carbon footprints. The study, published in June in *PNAS Nexus*, is about helping people to understand which of their lifestyle choices has the biggest impact on the environment. The researchers listed 26 choices, one of which was to "not purchase/adopt a dog".

The three choices that cut carbon emissions significantly and were relatively easy to do (sorry, had high "behavioral plasticity") were: "taking one fewer flight, not adopting a dog, or eating lower-carbon meats". However, a lot of people apparently don't really get it.

What we are seeing resembles the telephone game, with a whispered message mutating as it passes from researchers to the media. The paper clearly isn't about dogs, given its title: "Climate action literacy interventions increase commitments to more effective mitigation behaviors".

It may be possible to draw a tortuous line from carbon emissions due to dog ownership (mostly from producing dog food) to extreme weather. But this, Feedback thinks, would be to bark up the wrong tree.

Twisteddoodles *for New Scientist*

YOU ALL SET FOR THE MEETING?
COULDN'T IT BE AN EMAIL INSTEAD?
BUT IT IS A SCIENTIFIC MEETING WITH PRESENTATIONS AND TALKS
OR A SCIENTIFIC EMAIL WITH SOME NICE ATTACHMENTS
@twisteddoodles

Got a story for Feedback?
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or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

The other game

Feedback has once again lost The Game. As previously discussed in these pages, all humans are playing The Game at all times, the sole objective of which is to not remember that you are playing The Game. Hence you have just lost The Game, and you will every time you look at this page, or think about it, ever, for the rest of your life.

If that prospect doesn't appeal, Robin Stevens offers a possible salve. He highlights the 391st edition of webcomic *xkcd*, which is called "Anti-Mindvirus".

It is a single panel comic, containing the words "YOU JUST WON THE GAME. IT'S OK! YOU'RE FREE!" The alt-text adds: "I'm as surprised as you! I didn't think it was possible."

Problem solved, unless, of course, someone writes a follow-up that reads: "NO YOU HAVEN'T!"

Deeper and deeper

We've all heard about fake images and videos, often produced by artificial intelligence, that go viral and mislead millions of people. These are only going to become more common as AI tools get better. But readers will perhaps be less familiar with fake AI journalists.

If you haven't heard of "Margaux Blanchard", she is a freelance journalist whose name popped up a lot this year. Blanchard wrote about couples getting married in Minecraft (*Wired*), remote working and having a first child at 45 (*Business Insider*), Disneyland superfans (*SFGate*) and the challenges facing journalists in Guatemala (*Index on Censorship*).

Blanchard doesn't appear to exist. All her articles seem to be written by AI and mention other apparently made up people and organisations (*Minecraft* and Disneyland are real, obviously). The stories have now mostly been taken down.

But this type of thing keeps happening. On 6 September, *The Washington Post* reported that "a raft of articles have been retracted" by various publications, all stemming from "a possible broader scheme to pass off fake stories... written using artificial intelligence". Thank heavens that nothing big is happening that might require trustworthy coverage.

And there is a weird extra twist to the story. Back in July, Feedback wrote about The Velvet Sundown, a band with seemingly AI-generated songs and even publicity shots (19 July). The band was traced to one Andrew Frelon, who claimed to have created the whole thing, then backtracked, then un-backtracked.

Frelon has a blog on Medium with three entries: "I am Andrew Frelon, the guy running the fake Velvet Sundown Twitter", "So Yeah, I Did Make Velvet Sundown" and... wait for it... "So Yeah, I am Margaux Blanchard too. Oops."

Frelon claims he was paid by "a major media client" to answer the question: "Could a fully autonomous AI system produce credible news stories of sufficient quality that they could be sold to top-tier outlets?" The answer, apparently, is "yes". Of course, all this is based on what Frelon says, and he is just a Medium account with three posts and a photo. Maybe he isn't real, either.

Dominic Ponsford at *Press Gazette*, which broke the Blanchard story, put it very bluntly in his email newsletter: "Every time you receive an email from someone you do not know the assumption now has to be that they are not real."

The only lesson from this, feels Feedback, is that named journalists can't be trusted. Except for those hiding behind nonsensical and weird pseudonyms, naturally.

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